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Clark Fork River Operable Unit

of the Milltown Reservoir/Clark Fork River Superfund Site

Record Of Decision

Part 2: Decision Summary

U.S. Environmental Protection Agency
Region 8

10 West 15th Street
Suite 3200
Helena, Montana 59626

April 2004

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Exhibits **Page**

1 Site Name, Location, and Brief Description

Site Name:	Clark Fork River Operable Unit of the Milltown Reservoir/Clark Fork River Superfund Site (OU #3)
CERCLIS Identification Number:	MTD980717565
Site Location:	Missoula, Granite, Powell, and Deer Lodge Counties, Montana
Lead Agency:	U.S. Environmental Protection Agency
Support Agency:	State of Montana Department of Environmental Quality
Source of Cleanup Monies:	Potentially Responsible Party Enforcement or Settlement
Site Type	River and floodplain corridor impacted by historic mining and smelting wastes

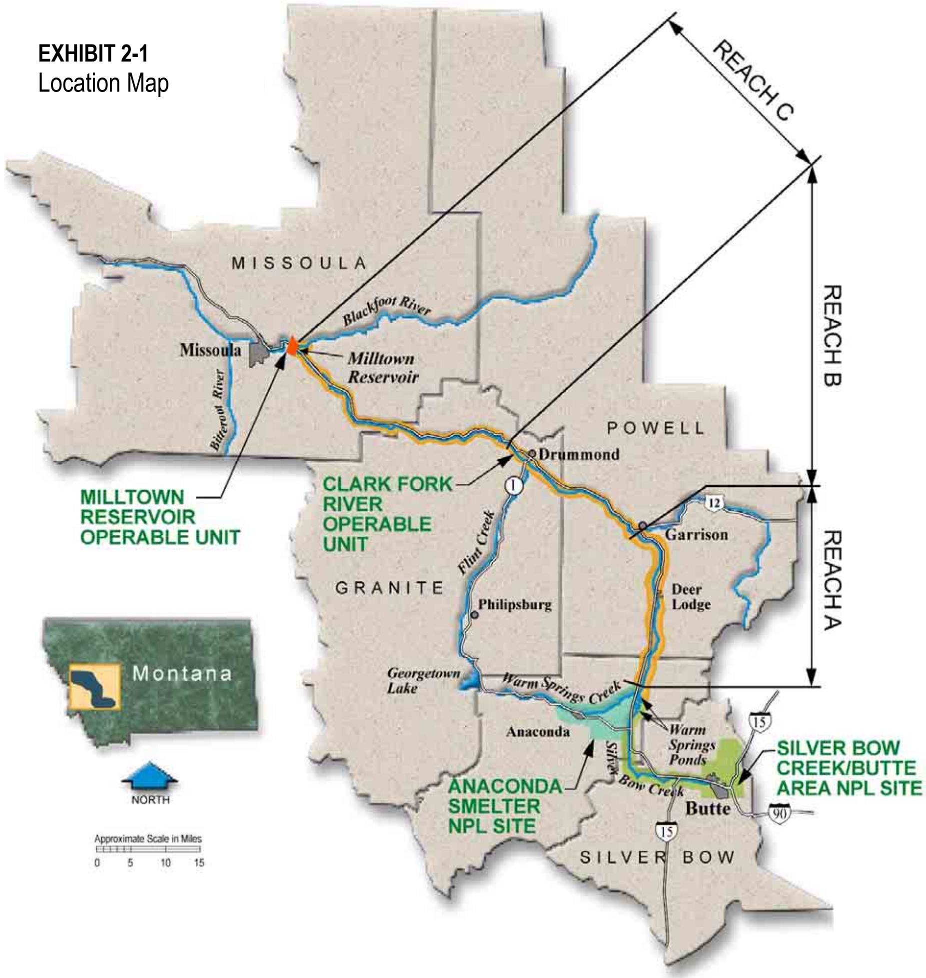
The U. S. Environmental Protection Agency (EPA), in consultation with the Montana Department of Environmental Quality (DEQ), is authorizing the Selected Remedy described in this *Record of Decision* to address about 120 river miles of the Clark Fork River, from the headwaters at Warm Springs Creek to Milltown Reservoir (just east of Missoula). Approximate boundaries are shown in Exhibit 2-1, *Location Map*.

EPA is the lead agency for the Clark Fork River Operable Unit (OU), and DEQ is the supporting agency. Numerous other entities, including government agencies, local governments, the Confederated Salish and Kootenai Tribes, academic research groups, landowners and public interest groups, have participated in the Superfund process up to the present. The potentially responsible party (PRP) is the Atlantic Richfield Company.

The Clark Fork River OU consists of surface water, stream bed sediments, tailings, impacted soils, groundwater, aquatic resources, terrestrial resources, irrigation ditches and related sediment deposition and contaminated property, and air located within and adjacent to the 100-year historic floodplain of the Clark Fork River. The OU extends from the confluence of the old Silver Bow Creek channel with the reconstructed lower Mill-Willow bypass, to the maximum Milltown Reservoir pool (see Exhibit 2-1, *Location Map*).

From its headwaters, the Clark Fork River flows north for approximately 43 river miles past the towns of Galen, Deer Lodge, and Garrison (this stretch is **Reach A**). The river then runs northwest for approximately 77 river miles to the headwaters of the Milltown Reservoir near Bonner (this includes **Reach B** and **Reach C**).

EXHIBIT 2-1
Location Map



Mining for gold, silver, and especially copper began in the late 19th Century in the Butte-Silver Bow Creek area. Milling and smelting of these ores produced vast wealth and concurrently a variety of mining, milling, and smelting wastes, including mine waste rock, mill tailings, and mill process waters that were released into Silver Bow Creek as late as 1982 and continue to be re-released to the present day throughout the Clark Fork Basin.

These various mining wastes retained the mineral signatures of the ore bodies and typically contained elevated levels of metals and arsenic as well as the acid producing mineral iron pyrite. The finer sized mining wastes mixed with streambed sediments as they were hydraulically transported downstream. Sediment transport rates varied depending on stream flow conditions caused by precipitation patterns. Large flood events, particularly in 1908, distributed the metal bearing sediments along the entire upper Clark Fork River floodplain. Sedimentation ponds constructed at Warm Springs in 1918 and the late 1950s altered the amounts and size ranges of contaminated sediments reaching the upper Clark Fork River from Silver Bow Creek. Wastes from mines, mills, and from the Old Works Smelters in Anaconda were also transported as contaminated sediments via Warm Springs Creek and other creeks into the upper Clark Fork River. Aerial deposition from the large Anaconda Smelters also contributed to the contamination of the Clark Fork River.

In addition to fluvial deposition of metals contaminated sediments within the historic 100-year floodplain, agricultural fields were irrigated with water from the Clark Fork River that at times contained elevated concentrations of metals in the dissolved form and as suspended sediment. This caused ongoing contamination, at low levels, of the fields. In some instances, irrigation ditches overflowed or were breached, flooding fields downgradient of the ditches with river water. Soils in these irrigated fields and ditches now contain elevated concentrations of metals and arsenic resulting from these historic irrigation practices. The irrigated fields are located on terraces above the influence of metals and arsenic impacts associated with flood deposition.

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2 Site History and Enforcement Activities

Placer mining for primarily gold began in the mid to late 1800s in the Butte-Silver Bow Creek area. These early activities contaminated local areas, but did not contribute extensive tailings to the river. As mining activity increased, underground mining began for gold, silver, copper, and other metals. The mining and milling of deeper copper sulfide ores in Butte and Anaconda began during the 1880s and contributed much of the mining waste residuals now found in the Clark Fork River OU. The introduction of electricity in the early 1900s enhanced mining, milling, and smelting practices and production rates increased significantly, thereby increasing mine wastes discharged to Silver Bow Creek.

In the Butte area, mining companies routinely disposed of mining and milling wastes directly into Silver Bow Creek. The mining wastes were carried away and mixed with river bed sediments by the various higher seasonal flow events in Silver Bow Creek and much was subsequently carried into the upper Clark Fork River. Large quantities of wastes from the Anaconda Company's operations in Anaconda reached the Clark Fork River by washing down Warm Springs Creek and other tributaries. Aerial deposition from the Anaconda Smelter operations also contributed to the metal levels in the Deer Lodge Valley, and to the runoff of these metals into the river.

In early 1908, the largest flood event on record for the Clark Fork drainage occurred during late winter when a warming trend resulted in heavy rains that fell on snow and frozen ground. This resulted in flooding down the entire Clark Fork drainage. During this event, extensive quantities of waste, contaminated soils, and contaminated sediments were deposited on the floodplain.

Because of complaints of ranchers and farmers on the Clark Fork River, in 1918 the first two of three sedimentation ponds were constructed on Silver Bow Creek at Warm Springs to reduce the amount of contaminated sediments being transported downstream. A third, much larger settling pond was built in the late 1950s. It was estimated in the Warms Springs Pond *Remedial Investigation* (EPA 1989) that more than 19 million cubic yards of sediments are contained in the three settling ponds. From 1918 to the present day, the Warm Springs Ponds system, although only partially efficient and relatively simple, prevented significant quantities of mining and milling wastes from moving downstream into the Clark Fork River.

Since 1990, significant remedial and removal action clean-up efforts have been conducted upstream of the Clark Fork River, including the Warms Springs Ponds OUs, which substantially improved the efficiency of the sedimentation ponds, ongoing cleanup of Silver Bow Creek, and other cleanups completed in the Butte area, such as Lower Area One (LAO).

Since 1987, numerous investigations, clean-up studies and demonstration projects have been conducted on the Clark Fork River OU. The Atlantic Richfield Company prepared major portions of the final Clark Fork OU *Remedial Investigation* and *Feasibility Study*, completed several in-situ demonstration projects and streambank stabilization projects, and conducted a Time Critical Removal Action (TCRA) at Eastside Road in Deer Lodge. EPA, in consultation with DEQ, provided oversight of the *Remedial Investigation* and *Feasibility Study* activities conducted by the Atlantic Richfield Company. EPA produced the *Human Health* and *Ecological Risk Assessments*, including addendums, and the geomorphological studies. EPA also produced the Clark Fork River OU *Proposed Plan*.

Key documents regarding the Clark Fork River OU include the following:

- Clark Fork River Screening Study—1991, CH2M HILL, Chen-Northern, and Montana State University (MSU) Reclamation Research Unit.
- Clark Fork River OU *Remedial Investigation Report Final Draft*—The Atlantic Richfield Company 1998, approved by EPA.
- Clark Fork River OU *Human Health Risk Assessment.*
- Geomorphology, Floodplain Tailings, and Metal Transport in the Upper Clark Fork Valley, Montana—USGS and the Atlantic Richfield Company 1998.
- Clark Fork River OU *Ecological Risk Assessment*—prepared by Syracuse Research Corporation for EPA—2001.
- *Human Health Risk Assessment* addendum—prepared by Syracuse Research Corporation for EPA—2001.
- National Remedy Review Board (NRRB) Presentation Package, Clark Fork River OU of the Milltown Reservoir Sediments Superfund Site—EPA Region 8, Montana office, April 2001.
- Clark Fork River OU *Feasibility Study*, *Public Review Draft*—The Atlantic Richfield Company 2002, approved by EPA. This report contains a detailed list of ARARs.
- Responses to Issues Posed by the EPA NRRB regarding Phytostabilization of the Clark Fork River OU, Milltown Sediments Superfund Site—EPA Region 8, Montana Office, December 2001.
- Superfund Program Clean-up Proposal, Clark Fork River OU of the Milltown Reservoir/Clark Fork River Superfund Site (*Proposed Plan*)—EPA Region 8, Montana office, August 2002.

2.1 Chronology of Enforcement Activities and PRPs

Following is the chronology of enforcement activities and identification of PRPs, as shown on Exhibit 2-2, *Site History Timeline*:

- 1864 to 1900: Localized gold, silver, and copper mining by a variety of companies and owners in the Clark Fork Basin.
- 1885 to 1910: War of the Copper Kings. The Anaconda Company acquires most of the copper properties and facilities in Butte and constructs the Anaconda facilities.

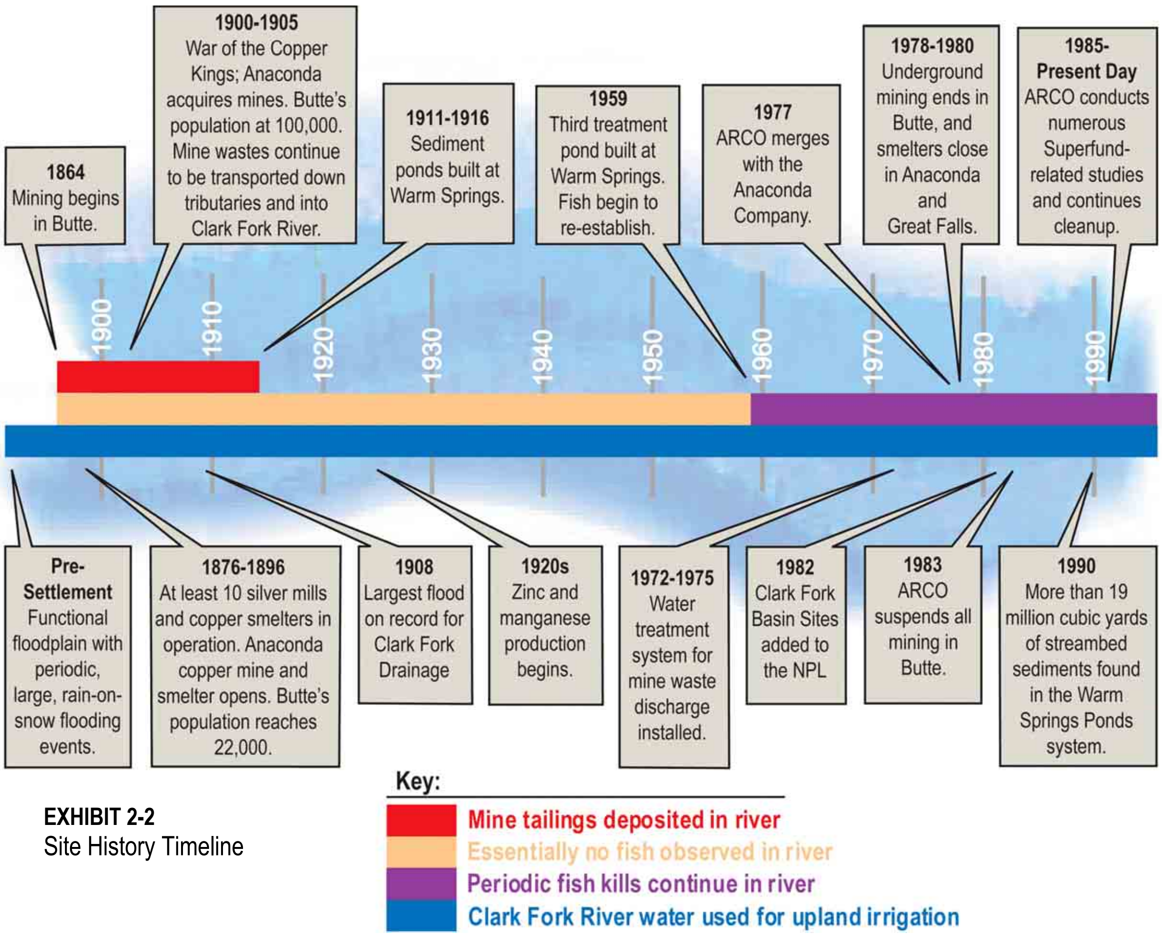


EXHIBIT 2-2
Site History Timeline

- 1900s to 1970s: Essentially uncontrolled releases of mining and milling wastes to Silver Bow Creek continued.
- 1977: The Atlantic Richfield Company merges with the Anaconda Company.
- 1982: Three sites are added to the National Priority List (NPL): the Silver Bow Creek/Butte Area Site, the Anaconda Smelter Site, and the Milltown Reservoir Site.
- 1983: The Atlantic Richfield Company suspends all mining activity in Butte, after shutting down the Anaconda smelter.
- 1985: Washington Corporation purchases Butte operations from the Atlantic Richfield Company, and begins operations of Continental Pit and Weed Concentrator a year later, eventually under the name of Montana Resources.
- 1989: United States sues the Atlantic Richfield Company for reimbursement of costs at the three sites; litigation is ongoing, although stayed and partially settled.
- 1991: State of Montana actively pursues its natural resource damages litigation against the Atlantic Richfield Company.

- 1994 to 1995: EPA gives notice to the Atlantic Richfield Company of its liability at the Clark Fork River OU and enters into an Administrative Order on Consent for conduct of the Clark Fork River OU *Remedial Investigation* and *Feasibility Study*.
- 1997 to 1998: The Atlantic Richfield Company and the State of Montana conduct a trial in U.S. District Court regarding natural resource injury and damages, centering on the Clark Fork River Basin contamination.
- 1999: The Atlantic Richfield Company, the State of Montana, the United States, and the Confederated Salish and Kootenai Tribes reach a settlement of certain natural resource damages and some response actions, and Clark Fork River OU response and natural resource damages claims are reserved for future, post-*Record of Decision* settlement.
- 2000: EPA issues a time-critical removal action memorandum to address immediate human health risks for residents of Eastside Road in Deer Lodge, in response in part to an Agency for Toxic Substances of Disease Registry health consultation and EPA *Human Health Risk Assessment* action levels, and issues a Unilateral Administrative Order to the Atlantic Richfield Company for implementation.
- 2001: EPA Region 8 presents their Preferred Remedy to the NRRB.
- 2002: To the extent practicable, following the NRRB's recommendations, as well as input from the numerous stakeholders and the State of Montana, EPA issues a *Proposed Plan*. A 4-month comment period takes place.
- 2004: EPA issues this *Record of Decision*.
- Post *Record of Decision*: Court-ordered Clark Fork River OU settlement discussions will commence, addressing EPA response costs and implementation and related natural resource damages claims.

3 EPA, State, and Community Participation in the RI/FS Process

The *Remedial Investigation* began in 1995 with extensive public involvement. Concurrently, EPA, in consultation with DEQ, prepared a community relations plan to identify and set forth agency and community interaction during the *Remedial Investigation* and the *Feasibility Study* (RI/FS). Under the plan, EPA conducted community interviews and issued several fact sheets. EPA also extended a technical assistance grant to the Milltown Technical Assistance Committee (later renamed the Clark Fork Technical Assistance Committee [CFRTAC]) to provide the public with independent technical reviews of EPA and DEQ Clark Fork River RI/FS activities, reports, and meetings. During the first year, many stakeholders were interviewed and numerous public meetings were held throughout the river basin. Upstream landowners and downstream environmental organizations expressed widely disparate views of the river's health and how it should be cleaned up. For example, EPA's *Human Health Risk Assessment* (1998a) found minimal risk to humans, because relatively few opportunities exist for direct exposure to floodplain contamination. But some groups criticized EPA's findings of minimal risk, citing concern about "hot spots" of arsenic in the floodplain. EPA worked with the Agency for Toxic Substances and Disease Registry (ATSDR), a Federal agency that focuses on public health issues, and issued an Addendum to the *Human Health Risk Assessment* to address these concerns. EPA also conducted a series of public meetings and discussion groups on the *Ecological Risk Assessment*. EPA responded to comments from the Atlantic Richfield Company and others on the risk assessment. EPA also sought and responded to comments on the *Remedial Investigation* report. The State and other natural resource damage trustees were consulted in the development and issuance of these documents.

The *Feasibility Study* began in March 2000. EPA facilitated a *Feasibility Study* technical advisory group, composed of as many as 40 to 45 interested individuals, including public interest group representatives, county government officials, and Federal, Tribal, and State agency representatives. This group met monthly during the development of the *Feasibility Study* from March through October 2000 to review data, track the progress of the Atlantic Richfield Company's efforts on the *Feasibility Study*, and provide input toward the development and analysis of *Feasibility Study* alternatives.

After the preliminary draft *Feasibility Study* was submitted by the Atlantic Richfield Company to the agencies, EPA facilitated the gathering of a smaller group of stakeholders. A few of the individuals in this "working group" (15 to 20 members) had participated in the larger technical advisory group. However, the latter group did not include Federal, State, or Tribal agency representatives. Rather, it was composed of representatives from local governments (four separate county governments), landowners, and environmental organizations. This working group, with the assistance of a professional facilitator, met several times in a setting that was conducive to understanding each other's interests and needs and supportive of development of a dialogue between "upstream interests" and "downstream interests."

During EPA and DEQ review of the Atlantic Richfield Company's preliminary draft Clark Fork River *Feasibility Study*, serious shortcomings were noted relative to the lack of alternatives developed and evaluated for reducing the extent of streambank erosion and providing geomorphic stability of the river's banks and floodplain. EPA, in consultation with the State, prepared comments back to the Atlantic Richfield Company requiring that a series of subalternatives be developed utilizing a streambank riparian buffer zone and streambank stabilization concept to mitigate this problem. The Atlantic Richfield Company was required to modify the final draft Clark Fork River *Feasibility Study*, which was released March 2002, to include and evaluate such subalternatives.

Both the technical advisory group (including CFRTAC) and the working group participated in various technical and policy discussions about the Clark Fork River OU. These discussions also assisted the remedy selection process: the advice, recommendations, and expressed concerns added significantly to EPA's understanding of community views of the proposed remedy. In May 2001, EPA Region 8 presented its suggested remediation strategy to the EPA NRRB. The State of Montana and some participants of the two working groups provided the NRRB with their perspectives on the proposed cleanup action. Various questions regarding the suggested remedy raised by the NNRB were subsequently responded to by EPA Region 8 and a symposium on in-situ treatment was held.

Stakeholder interaction continued throughout the development of the *Proposed Plan*. Meetings were held with individual landowners, the groups described in this section, and the community at large. An information video was prepared to present the various viewpoints on what should be done with the site. EPA hosted two open houses about the site in April 2002.

The *Proposed Plan* was released in August 2002, along with a Fact Sheet summarizing the plan. The RI/FS reports and the *Proposed Plan* were made available to the public at this time or previously, placed in the Administrative Record, and made available at several information repositories located throughout the Clark Fork River Basin. A 60-day public comment period began. Two extensions were granted, giving the public nearly 4 months to provide input to the remedy selection. Two public meetings were held during the first month of the comment period: one meeting in Deer Lodge, Montana, and a second meeting in Missoula, Montana. At these meetings, EPA and DEQ representatives presented information, answered questions, and receive public comment for the record. EPA's response to the comments received during the public comment period is included in the *Responsiveness Summary*, which is Part 3 of this *Record of Decision*.

4 Scope and Role of OU or Response Action

The Clark Fork Basin Superfund complex is made up of four contiguous sites broken into OUs for easier management:

- Silver Bow Creek/Butte Area Site—established 1982
  - Butte Priority Soils OU and several related removal OUs
  - Lower Area One/Ecological Risk Assessment OU
  - Mine Flooding/Berkley Pit OU
  - Westside Soils OU
  - Butte Active Mine Area OU
  - Rocker OU
  - Streamside Tailings OU
  - Warm Springs Ponds OUs (Two remedial and one removal)
- Montana Pole Site—established 1987
- Anaconda Smelter Site—established 1982
  - Smelter Demolition Removal OU
  - Mill Creek Temporary Relocation Removal OU
  - Mill Creek Final Relocation Remedial OU
  - Anaconda Yards Removal OUs
  - Old Works Removal OU
  - Flu Dust OU
  - Old Works/East Anaconda Development OU
  - Anaconda Community Soils OU
  - Anaconda Warm Springs Creek Removal OU
  - Anaconda Regional Water, Waste, and Soils OU
- Milltown Reservoir Sediments Site—established 1982
  - Milltown Water Supply OU
  - Milltown Reservoir Sediments OU
  - Clark Fork River OU and the related East Side Road Removal

The combined sites include more than 140 miles from the headwaters of Silver Bow Creek north of Butte to the Milltown Dam near Missoula. The four sites are shown in Exhibit 2-1, *Location Map*, page 2-2. EPA and DEQ have been methodically addressing these sites over the last 20 years. The Clark Fork River OU final remedy is one of the last cleanup decisions needed for the Clark Fork River Basin complex.

The Clark Fork River OU is one of three remedial OUs within the Milltown Reservoir Sediments Site. The other OUs are the Milltown Water Supply OU and the Reservoir Sediments OU. Although these sites are contiguous, the OUs within them have been divided such that actions in one site or OU are not dependent on activities in other areas. As noted earlier, the Deer Lodge irrigated lands TCRA is addressing clear human health threats at the Clark Fork River OU by using EPA's removal authority. That action's remaining components will become part of this final Clark Fork River OU Selected Remedy. The Clark Fork River OU Selected Remedy is meant to address comprehensively the human health and environmental risks and other response action issues identified for this area. It does not address natural resource damage claims related to the establishment of baseline conditions at the Clark Fork River OU—these will be addressed separately by the State and Federal natural resource damage trustees.

5 Site Characteristics

5.1 Conceptual Site Model

The primary source of contaminants of concern in the Clark Fork River floodplain is tailings mixed to various degrees with surface and near surface soil deposits within the historic 100-year floodplain. Secondary sources include contaminated surface water and shallow groundwater from the alluvium within the Clark Fork River OU. Other secondary sources include streambed sediments and some historically contaminated irrigation ditches and fields.

The primary pathways by which contaminants move within and between media include tailings and soils, groundwater, surface water, and airborne transmissions. Fate and transport of contaminants by these media are listed below and shown in Exhibit 2-3, *Conceptual Model*:

- Tailings, Sediments, and Impacted Soils
  - Oxidation of tailings produces acid, releases metals into surface and groundwater
  - Plants uptake contaminants from soil into roots
  - Overbank flow from flooding, rainfall, and streambank erosion transport total and dissolved metals into river; aquatic flora and fauna exposed
- Groundwater
  - Infiltration and vadose zone transport
  - Vadose zone pore-water and groundwater interaction
  - Groundwater flow
  - Groundwater and surface water interaction
  - Streambank storage
- Surface Water
  - Surface water runoff from tailings
  - Surface water and sediment interaction
  - Streambank and floodplain erosion by the Clark Fork River
- Streambed Sediments
  - Streambed material coated with metal oxides, sulfides, and hydroxides – potential dissolution into the river water.
- Historically Irrigated Fields
  - Soil entrainment by wind, potential inhalation and ingestion by residents
  - Dermal contact with soil, potential for ingestion by children
  - Ingestion potential through garden vegetables

- Biological resources
  - Soil and aquatic organisms exposed through consumption of contaminated soils or absorption of water. Runoff from summer thunderstorms represents a mechanism for transport of contaminants.
- Airborne Transmissions
  - Dust entrainment

The factors influencing the conceptual site model are discussed in more detail throughout this section. Primary pathways by which humans may be exposed to contaminants are presented in Exhibit 2-4, *Conceptual Model for Human Exposures*. Ecological risk pathways are presented in Exhibit 2-5, *Conceptual Model for Ecological Exposures.*

5.2 Site Overview

5.2.1 Site Size, Geography, and Topography

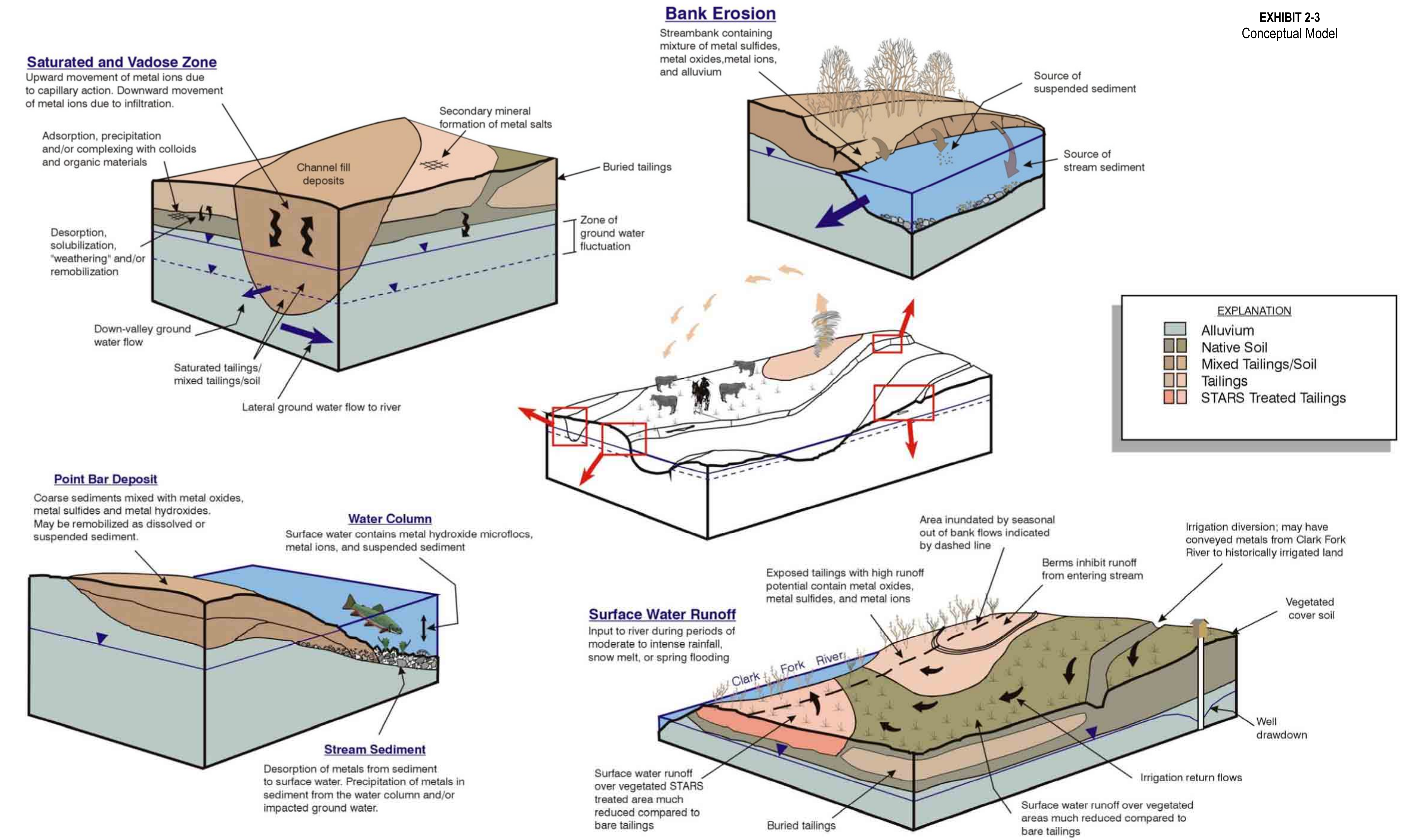
The Clark Fork River is an easterly tributary of the Columbia River and is the major drainage system of Montana's mountains west of the Continental Divide. The river flows generally northwest to enter Lake Pend Oreille in northern Idaho. The waters exit Lake Pend Oreille near Sandpoint, and flows through the Pend Oreille River to the confluence with the Columbia River in British Columbia, Canada.

The Clark Fork River OU consists of 120 river miles of floodplain and irrigated fields at the upper end of the Clark Fork River Basin. Along the many portions of the OU, the river is bounded or traversed by Interstate 90 (I-90), secondary roads, and two railroads (one active, one abandoned). The placement of these structures has diverted and channelized the natural course of the river in some areas, primarily in Reaches B and C (as described below).

The Clark Fork River flows through the Deer Lodge Valley, which is a structural depression filled with Tertiary basin-fill and Quaternary alluvium eroded from the surrounding highlands. The sediments in the Deer Lodge Valley are as much as 5,000 feet thick and include a heterogeneous mixture of gravel, sand, silt, and clay. The broad, meandering form of the Clark Fork River in Deer Lodge Valley reflects this depositional history. The valley becomes more narrow and the river less meandering after Garrison, where the gradient increases and the lithology changes to sedimentary rocks. The metamorphosed sandstones and shales encountered downstream of Bearmouth Canyon are more resistant to erosion than the dominantly carbonate sedimentary rocks of the Garrison to Bearmouth section.

To study and evaluate the best application of remedy solutions, the Clark Fork River was divided into three reaches based on physical features of the landscape, proximity to historic mining, and intensity of impacts.

EXHIBIT 2-3
Conceptual Model



Note: This conceptual model does not address overbank flooding

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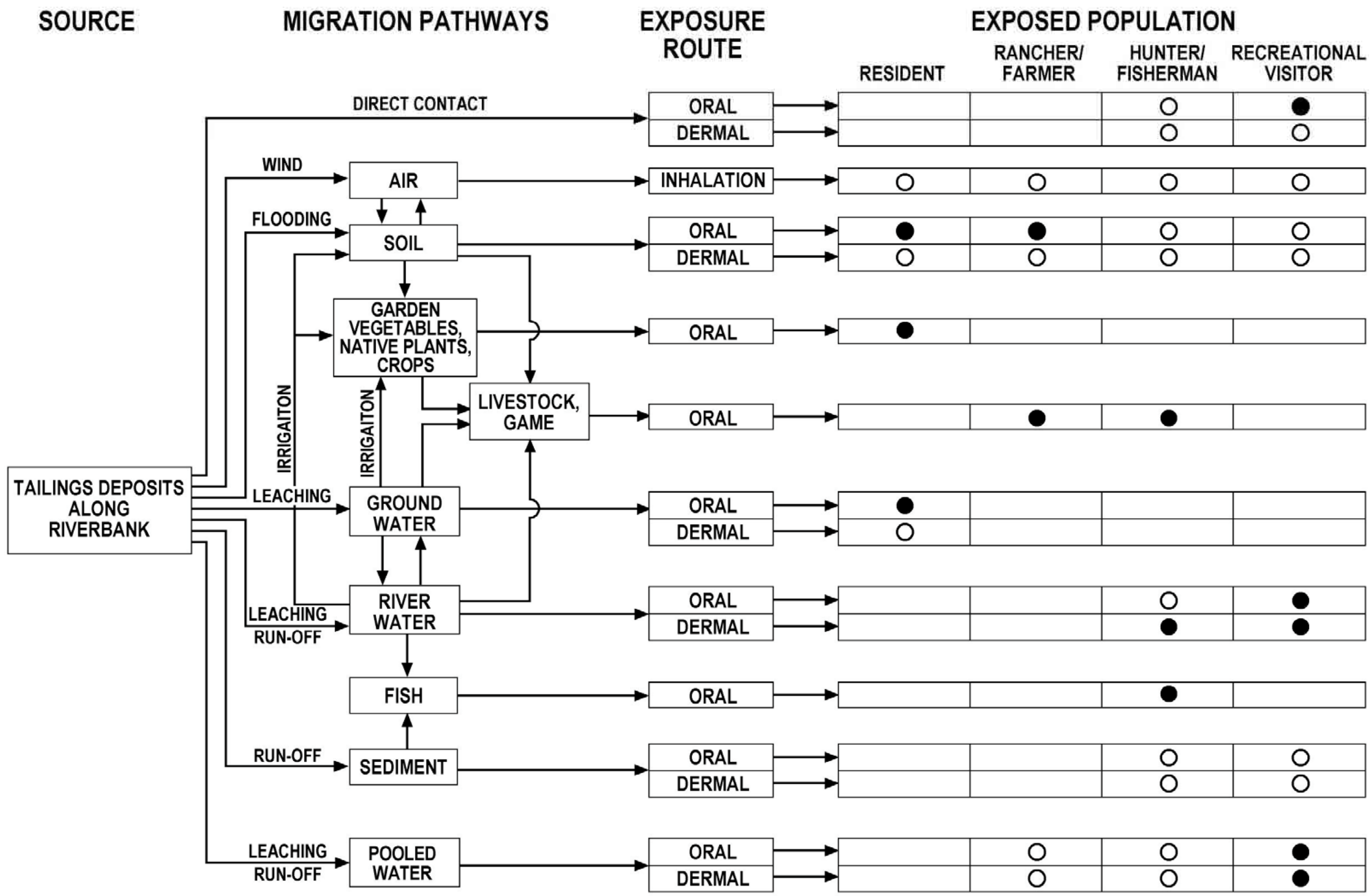
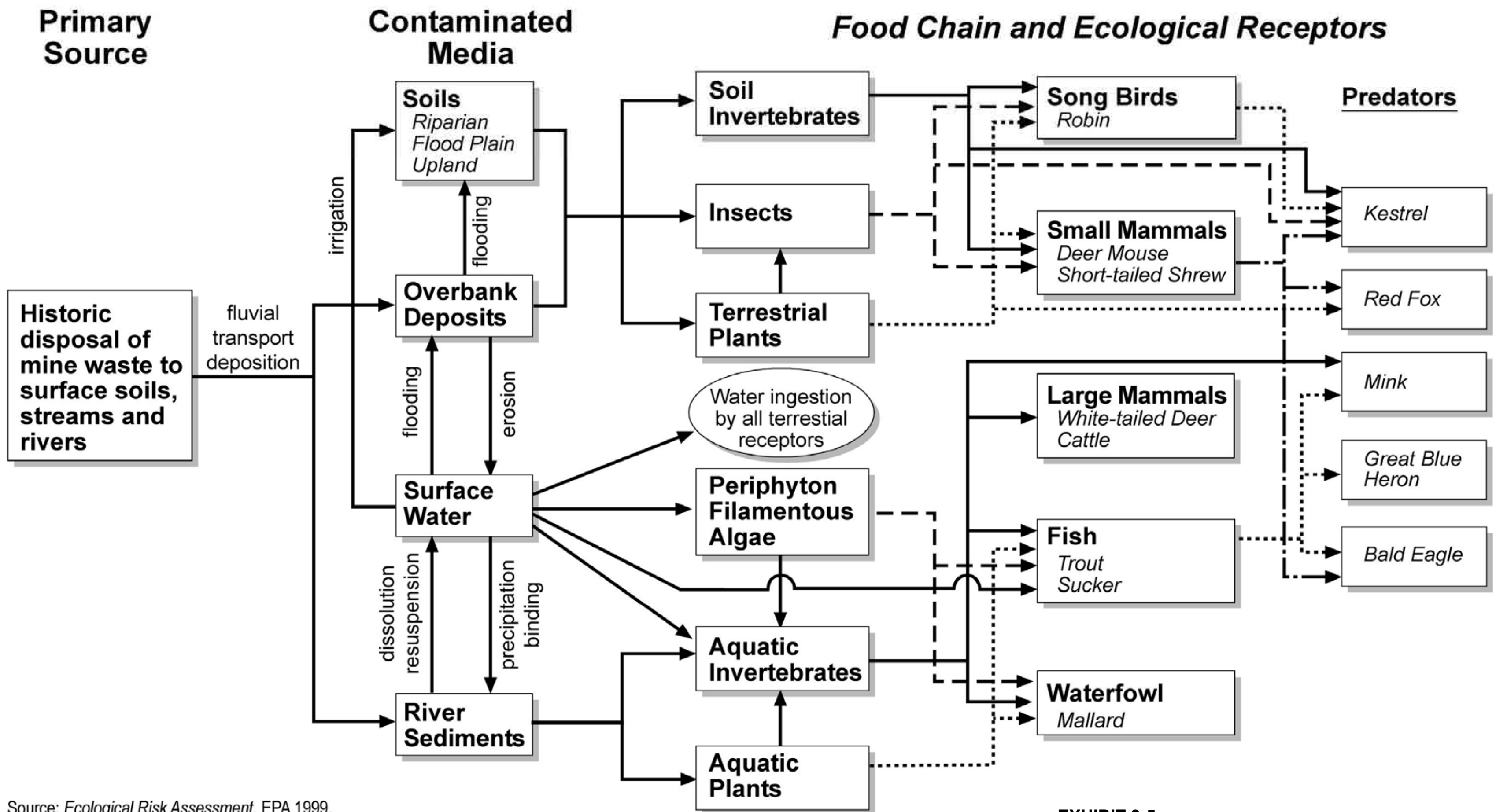


KEY:

- ● Potentially significant pathway; quantitative evaluation
- ○ Minor pathway; qualitative evaluation
- (blank) Incomplete pathway; not evaluated

EXHIBIT 2-4
Conceptual Model for Human Exposures

Source: *Human Health Risk Assessment*, EPA 1998a.



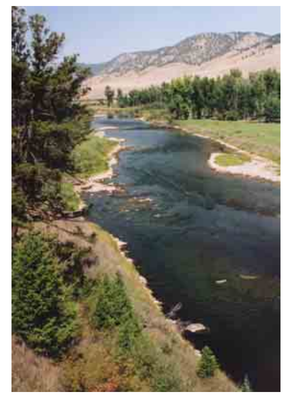
Source: *Ecological Risk Assessment*, EPA 1999.

EXHIBIT 2-5
Conceptual Model for Ecological Exposures

These reaches are described and illustrated below:

Reach A: Deer Lodge Valley, View from Garrison looking upstream.

- **Reach A—Deer Lodge Valley Reach:** Extends from the southeastern tip of the OU near river mile 0 at Warm Springs Creek to just upstream of Garrison at river mile 43. Reach A has the broadest extent of the 100-year floodplain and is nearest to historic mining and milling sites in Butte and Anaconda. Extensive exposed tailings and unstable streambanks, as well as stressed vegetation, exist in this area.
- **Reach B—Drummond Valley Reach:** Extends from immediately upstream of Garrison, where the Little Blackfoot River enters the Clark Fork, to downstream of Drummond at river mile 76, for a total of 31 river miles. At the starting point for this reach, the addition of water from the Little Blackfoot River may, under certain flow conditions, nearly double the Clark Fork's flow. The floodplain is more narrow and the gradient higher than Reach A, and exposed tailings are far less extensive.



Reach B: Clark Fork Valley; view near Drummond as valley narrows.

- **Reach C—Bearmouth Canyon Reach:** Extends 47 river miles from Drummond to the northwest tip of the OU area. Through this reach the floodplain is constrained by a narrow valley, roads, and railroad grades. Here, the flow is augmented by several tributaries and the reach is farther away from historic mining sites. No exposed tailings are evident.

Reach C: Bearmouth Canyon; river bordered by steep rock walls.

Studies performed for the *Remedial Investigation* and the *Feasibility Study* have shown that a focused cleanup effort in Reach A results in the greatest reduction in mine waste contamination. Efforts in Reach B would be expected to provide limited additional benefit. Reach C has more limited risks and no clear clean-up alternatives because of the widespread contamination and mixing of the contamination with fluvial soils, and the lack of feasible alternatives.

5.2.2 Important Archeological and Historical Features

Because of the size and complexity of this site, a unique, three-phase approach was used at the Clark Fork River OU to investigate cultural and historic resources:

- First, existing public information was summarized during the *Remedial Investigation*.
- Second, potential impacts to archeological and historical features were evaluated in the *Feasibility Study* based on the information gathered during the *Remedial Investigation* phase.
- The third investigation, if needed, will be a detailed inventory conducted during the remedial design phase of the project following publication of this *Record of Decision*.

The State Historic Preservation Office (SHPO) file search revealed 53 potential cultural resource sites in the Clark Fork River OU and adjacent areas. Two of these sites are currently included in the National Registry of Historic Places: the Grant-Kohrs Ranch National Historic Site and the William K. Kohrs Memorial Library in Deer Lodge. Twenty-five sites are potentially eligible for listing, 21 sites are indeterminate, and 3 sites have been declared ineligible.

Additionally, the Confederated Salish and Kootenai Tribes are conducting a survey to identify protected cultural, historical, and religious resources that have not been previously identified, under cooperative agreement funding from EPA. These results will be incorporated into the remedial design process according to procedures outlined in an agreement between EPA and the Tribe.

5.2.2.1 The Grant-Kohrs Ranch: A National Historic Site within a Superfund Site

A Survey of Historic Sites and Buildings was administered by the U.S. Department of the Interior (DOI) in 1957. The program was intended to identify and evaluate nationally significant properties throughout the United States and, with owner consent, designate them as National Historic Landmarks. Ultimately, these were eligible for consideration for inclusion in the National Park System.

One of the properties identified during this process was a working cattle ranch owned by Conrad Kohrs Warren at Deer Lodge, Montana. Now known as the Grant-Kohrs Ranch National Historic Site, it was the site of one of Montana's earliest ranches, and it eventually became one of the largest cattle raising operations in the West. This property was designated a National Historic Landmark on December 19, 1960. The legislation that designated the ranch as a National Historic Site was signed into law on August 25, 1972, and in November of that year, the National Park Service purchased the land.

Today, the Grant-Kohrs Ranch National Historic Site embraces 1,618 acres and 88 structures. The site is maintained as a working ranch. Emphasis at the ranch is on providing the visitor with "an understanding of the evolution of American cattle ranching, from open range to early farm-ranch cattle raising.…" The site is located within Reach A.

The National Park Service (NPS) has identified the Organic Act and associated designation legislation as an Applicable or Relevant and Appropriate Requirement (ARAR) to be applied to the Grant-Kohrs Ranch National Historic Site remedial action. EPA received extensive public comment on the *Proposed Plan*, urging adequate consideration of these unique ARARs in addressing remediation of the ranch. EPA has worked closely with the NPS to develop a description of how the Selected Remedy would be adapted and applied at the Ranch to meet the ARAR and protectiveness issues unique to the ranch. The description is found in Section 13.7, page 2-107.

5.2.3 Flood/Storm Event History and Geomorphic Features

Floods and other large storm events are the predominant natural force affecting the transport, mixing, and deposition of tailings and streambed sediments in the Clark Fork River historic 100-year floodplain. Although data from streamflow gauging stations upstream from Garrison are limited to the past 22 years, data are available for the past 100 years from gauging stations near Missoula.

In the early 1800s, and for centuries before, many of the meandering portions of Reach A of the Clark Fork River were likely impounded by beaver and supported dense populations of riparian shrubs. The beaver played an important role in shaping the floodplain, but were presumably eradicated by trapping in the early to mid-1800s. In Reaches B and C, the higher volume of water from the addition of the Little Blackfoot River and the steeper canyons resulted in a steeper river gradient, fewer meanders, and a reduced beaver population in these lower reaches.

The transport and mixing of acid generating mine wastes with streambed sediments and soils impacted to varying degrees the streambank and floodplain vegetation on Silver Bow Creek and the upper Clark Fork River. Existing streambanks and the denuded floodplain areas were also exposed to erosion and deposition. During significant flooding and storm events in the late 1800s and particularly in 1908, any remaining beaver ponds along the upper Clark Fork River probably contributed to the deposition of the thick layers of fine sediment and tailings on to the Silver Bow Creek and Clark Fork River floodplains. As a result, significant vegetation losses occurred on the banks and floodplain in Reach A because of the tailings and contaminated soils, primarily through acid releases resulting from the oxidation of the sulfides contained in the mine wastes (phytotoxicity).

Data from a stream flow gauge near Missoula indicate that large floods occurred in 1899 and 1908. Other large-magnitude floods likely occurred in 1887, 1892, and 1894. The 1908 flood lasted from May 25 to June 5, and resulted in the average deposition of channel sediments and tailings 1 to 3 feet thick in Reach A. Deposition of these silt-based mixed tailings could have occurred only if river flow over-topped the main channel and flowed into depositional areas across the floodplain. The depositional pattern also suggests that the floodplain was covered with substantial willow thickets that enabled the river to sustain its single-thread channel rather than become braided.

In Reaches B and C, the flows during floods, especially the 1908 flood, were likely higher and the bank vegetation was dominated by cottonwoods. Mixed tailings and sediments were likely deposited behind the cottonwoods in thin layers, but most of the tailings and soils were likely incorporated into the active bed of the channel.

The deposited, contaminated sediments, particularly in Reach A, were toxic to the riparian vegetation as the tailings materials began to oxidize, releasing acid and dissolved metals into the soils, surface waters and groundwaters. This loss of streambank vegetation, combined with other land use impacts such as farming and grazing, have made the banks susceptible to erosion. Since 1908, large peak flows have been recorded in 1948, 1964, and 1975. These and other storm water events continued to move contaminated waste into the Clark Fork River or re-released and mixed the existing contaminated sediments.

Currently, the portion of the upper Clark Fork River that meanders through the Deer Lodge valley (Reach A) is vulnerable to high rates of streambank erosion as a result of the loss of riparian woody vegetation. This condition is in addition to the other pathways, releases, and threats from the contamination that now resides along the Clark Fork River. The initial—and certainly the most significant—impacts to lost riparian woody vegetation occurred repeatedly throughout the late 1800s and into the early 1900s, as large quantities of mining and milling wastes were disposed of in the river’s headwaters. Each successive flood, whether major or minor, carried the mining wastes farther downstream and distributed them more broadly over the floodplain. Thus, the current floodplain, lacking extensive woody vegetation on the banks and in the riparian corridor throughout the Deer Lodge valley, is highly susceptible to ongoing streambank erosion and to potential catastrophic floodplain destabilization, or unraveling. As noted in the other sections of the *Record of Decision*, the contamination also presents other pathways and problems of significance that are addressed by the Selected Remedy.

5.3 Remedial Investigation Strategy

Because the Clark Fork River OU is such a large, complex site, much of the data gathering concerning sources of contamination, pathways of migration, and impacts on receptors needed for the *Remedial Investigation* relied on information from earlier treatability studies and demonstration projects, other Upper Clark Fork River Basin sites, and similar sites throughout the region. EPA, in concert with DEQ and the Atlantic Richfield Company, established specific Data Quality Objectives (DQOs) for reviewing studies and qualifying existing data sets for incorporation into the overall understanding of site conditions, and ultimately formation of a conceptual model. Work groups (focused around specific disciplines) consisting of EPA, DEQ (and other agencies), Atlantic Richfield Company, consultants, and other interested groups were formed under EPA direction to compile and evaluate existing information, and guide subsequent investigations through the formulation of work plans and Sampling and Analysis Plans, which would be used to fill data gaps and complete the characterization of environmental conditions. An example of one of the primary work groups was the geomorphology work group lead by U.S. Geological Survey (USGS) representative Dr. Jim Smith. This group was tasked with reviewing all existing information relevant to the physical processes (e.g., rate of erosion) that were influencing the dynamics and morphology of the Clark Fork River within the bounds of the OU. If deficiencies in the information were detected, this group made specific recommendations to generate the information needed. Pertinent studies and projects for all disciplines are cited in detail in the *Remedial Investigation* and the *Feasibility Study*.

5.4 Affected Media and Contaminant Types

As described in Section 5.1, *Conceptual Site Model*, page 2-13, the contaminants are found in media affected by mine wastes. The key media affected by contaminants in the Clark Fork River floodplain include the following:

- **Tailings and sediments and impacted soil:** The primary sources of contaminants are the tailings and impacted soils in streambanks and/or floodplain deposits. As shown in the conceptual model, several pathways exist from tailings and impacted soils to various biological receptors. Oxidation of the sulfides in the mining wastes is the key contaminant dissolution mechanism, producing acidity and dissolved metals that can migrate and contaminate surface water and groundwater. Plants can uptake contaminants directly from the soil through their roots, often resulting in phytotoxicity. Streambank erosion can increase total metals and suspended sediment in the river, which can then be ingested by aquatic life. Also, contaminated surface water runoff from exposed tailings or slickens (pulse events), can enter surface water and subsequently be available to aquatic, plant, and animal receptors. These areas, along with the historically irrigated areas, also provide a pathway for human uptake, via dermal contact, inhalation, or ingestion.

- **Groundwater:** Movement of contaminated shallow groundwater and groundwater infiltration through tailings and soil causes both upward and downward movement of certain metal and arsenic ions. Groundwater flow to surface water can also occur.
- **Surface water:** Surface water runoff, including overbank flows, as well as erosion from floodplain tailings and contaminated soils into the river, transports both dissolved and sediment-bound metals and arsenic. Inflow of contaminated groundwater can also increase levels of contamination in the surface water.
- **Streambed sediments:** Stream sediments can contain various metal precipitates from the water column and groundwater. Streambed sediments can be mixed or coated with metal oxides, sulfides, and hydroxides in point bar deposits and in other parts of the streambed and can contribute to contaminant concentrations in the river.
- **Historically irrigated fields:** Irrigation ditches and fields historically irrigated with Clark Fork River water containing mining related contaminants are also sources of concern. All potentially contaminated fields, including fields outside the historic 100-year floodplain, will be evaluated for human health concerns during remedial design. EPA is presently involved in a TCRA to address impacted soils at Eastside Road residences, the known area of unacceptable arsenic levels in these fields. Although landowners of all historically irrigated fields in this area have been notified of the potential threat to their health, some landowners have not yet provided the needed approval to complete the response actions on their properties.
- **Biological resources:** Metals can be delivered to aquatic and terrestrial organisms from any of the contaminated media listed above. Organisms, including benthic macroinvertebrates, receive the contaminants through direct consumption of contaminated sediment or through absorption in water. These organisms are in turn part of the food chain—for example, macroinvertebrates are eaten by fish and, if contaminated, have been shown to potentially reduce growth of trout (Stratus 2002). Contaminant uptake in plants is a well-documented occurrence and the source of problems for streambanks and impacted vegetation areas. Loss of vegetation adversely affects local wildlife habitat. In the past, pulse events, triggered by intense summer thunderstorms, have carried acidic, metal laden runoff from nearby slickens into the river, and have resulted in documented fish kills and impacts on other aquatic life. Likewise, spring runoff, floods, and ice scour events generate sediment that is detrimental to benthic macroinvertebrate populations, fish spawning success, other fish, and aquatic mechanisms.
- **Air resources:** Because of the location and relatively small areas noted as slickens, and the various levels of existing vegetation located on the impacted soils areas, fugitive dust emanating from these areas is not significant and any resulting adverse air impacts are considered to be highly unlikely. Therefore, this air pathway is not of further concern except during remedial action construction.

The remedial actions defined in the Selected Remedy, when implemented, will have beneficial mitigative and corrective effects on the affected media.

For the purposes of discussion, an example segment of Reach A in map view and cross-section is illustrated to represent the variety of contaminant sources within the Clark Fork River OU. Exhibit 2-6, *Map View and Cross-Section of an Existing River Meander Bend*, shows several key features of the floodplain, including the floodplain tab within the meander, exposed tailings, impacted soils, and sparse vegetation.

Contaminants present in the Clark Fork River OU are from historic mining and smelting processes upstream of the Clark Fork River. The contaminants of concern for the site are arsenic, cadmium, copper, lead, and zinc. Copper is the prime contaminant associated with environmental risk, and arsenic is the primary contaminant associated with human risks. Exhibit 2-7 shows results from one study that measured metals and arsenic in several different floodplain deposits. Concentrations of metals and arsenic were quite variable, but the geometric average copper concentration in "tailings" was 1,760 ppm. Since copper is the key contributor to aquatic risks (particularly from exposed tailings), additional copper data from other historic studies were reviewed and compared with this data. The geometric average copper concentrations from a total sample base of 164 "tailings" samples from five other studies (which did not meet EPA's initial rigorous DQO criteria, yet are still indicative of site conditions) ranged from 1,600 to 2,877 ppm (Lipton 1993; Lipton et al. 1995b; Brooks 1998; Nimick 1990; CH2M HILL 1991, Atlantic Richfield Company 2002).

More recent soils data collected by EPA in July 2003 (part of the CFR RipES field confirmation process—reported by MSU and Bitterroot Restoration Inc., RRU and BRI 2003) measured copper and arsenic concentrations in tailings and impacted soils areas along with co-located measurements of riparian vegetation function. Where vegetation was severely impacted (slickens), the copper and arsenic geometric average concentrations were 1,950 and 630 ppm, respectively. Where vegetation was only slightly impacted, copper and arsenic geometric average concentrations were much lower (640 and 160 ppm, respectively). These differences in metals and arsenic concentrations are important considerations in the degree of remediation that may need to be undertaken for various impacted areas of the floodplain.

The *Ecological Risk Assessment* was conducted, concentrations of contaminants were considered, and the subsequent risks to aquatic, wildlife, and terrestrial resources were determined. The *Ecological Risk Assessment* found unacceptable risks from the metals contamination to plants and aquatic life within the Clark Fork River OU. Slickens and impacted soils and vegetation areas show the impacts from these risks most clearly. Fish populations in the Clark Fork River OU are also impacted by these risks. The *Ecological Risk Assessment* also found the possibility of risks to wildlife, although significant uncertainty exists regarding these risks. In tandem with these findings, the fluvial geomorphology studies conducted primarily by the USGS found excessive rates of erosion along streambanks in the upper reaches of the Clark Fork River OU and found that there was the possibility of severe braiding or unraveling of the upper river in large floods. While there is also uncertainty regarding this latter finding, this braiding, even if limited to small sections of the river, would cause large inputs of contaminants and sediment into the river. A more detailed description of the risk assessment is found in Section 7, *Summary of Site Risks*, page 2-39.

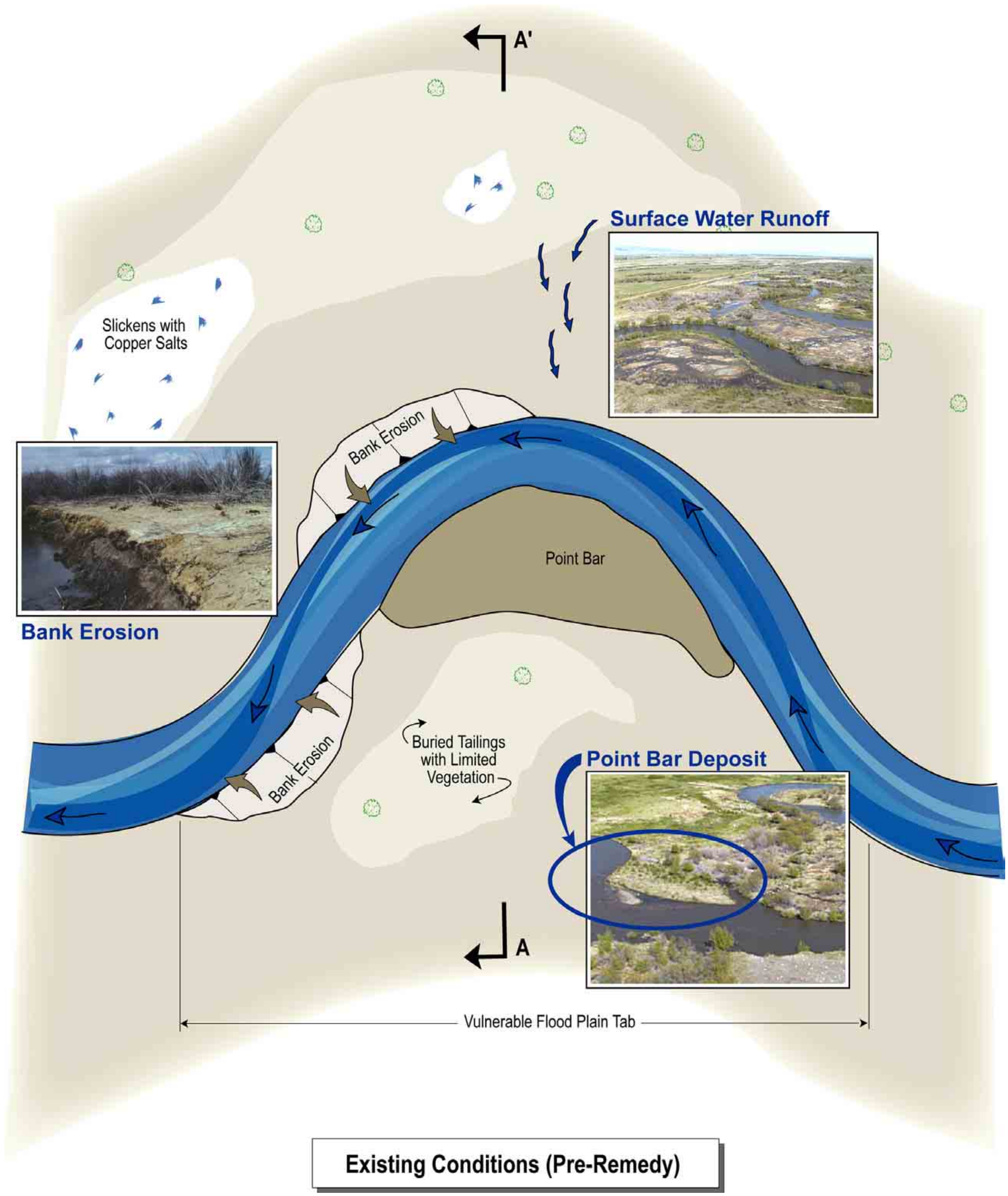


EXHIBIT 2-6
Map View and Cross-Section of an Existing River Meander Bend

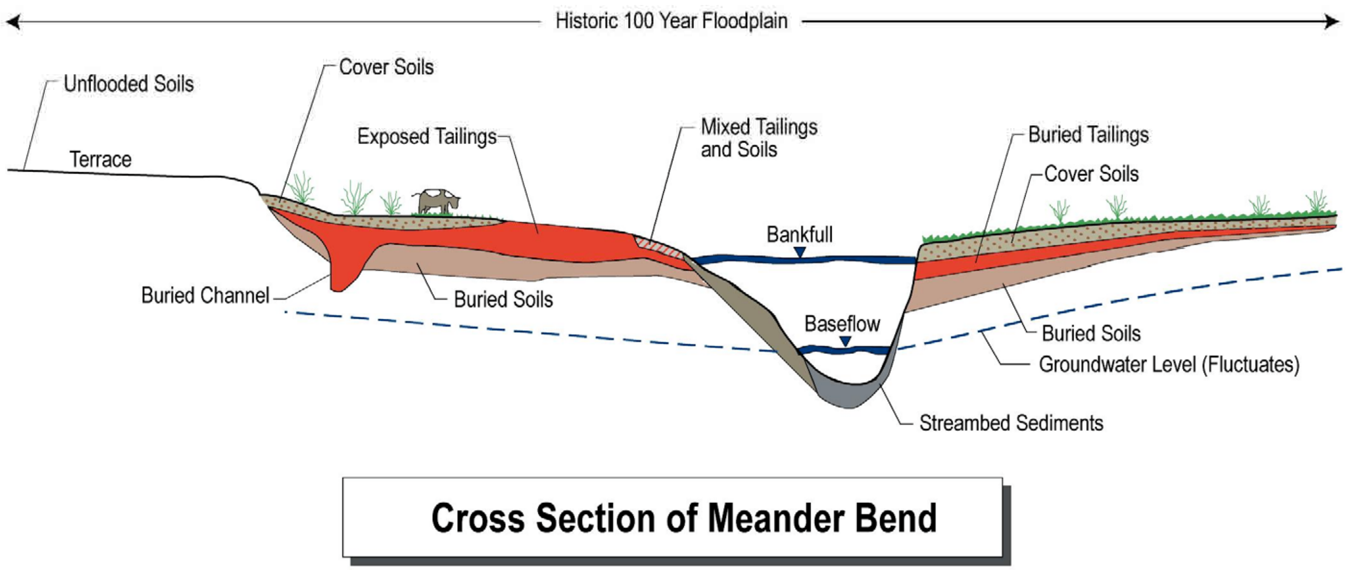


EXHIBIT 2-7
Geometric Mean Concentrations of Total Arsenic and Metals in Floodplain Sediments in Reach A of the Clark Fork Valley, Montana

Soil-material type	Number of samples	Geometric mean concentration (milligrams per kilogram)			
		Arsenic	Copper	Lead	Zinc
Tailings	21	766	1,760	665	1,530
Mixed soil/tailings	24	419	2,360	359	2,320
Buried soil	37	32	373	42	410
Buried alluvium	3	203	1,330	270	1,190
Cover soil	22	330	1,980	318	2,060
Unflooded soil	30	63	303	60	401

Source: Smith et al. 1998, Table 5, page 24. Data was also cited in the *Remedial Investigation*, Atlantic Richfield Company 1998.

The *Human Health Risk Assessment* identified arsenic as the contaminant of concern for assessing human health risks from the Clark Fork River OU contamination. Land use along the Clark Fork River riparian zone is primarily recreational or agricultural. The Clark Fork River *Human Health Risk Assessment* (EPA 1998a) and the *Human Health Risk Assessment Addendum for Recreational Visitors at Arrowstone Park* (EPA and ATSDR 2001) evaluated the human health risks arising from exposures to heavy metals and arsenic within tailings deposits, soils, and groundwater along the river. The studies concluded that, based upon the understanding that no residential development exists within the floodplain, and that exposures are limited to ranch (or farm) workers and recreators (fishermen, tubers, and children at parks), the human health risks are generally acceptable. On historically irrigated lands, however, where residential development has occurred or where it may occur in the future, the risk assessment concludes that risks may be unacceptable. NPS conducted a

Human Health Risk Assessment for the Grant-Kohrs Ranch National Historic Site (Foster Wheeler 2003) and found potential risks to workers from contaminated sediments in irrigation ditches that may be unacceptable.

In summary, the primary source of contaminants in the Clark Fork River channel, streambanks, and historic 100-year floodplain is the presence of mine wastes, which have been mixed to varying degrees with channel sediments and soils. Contaminants have moved from this primary source to media that can serve as secondary sources, including groundwater, surface water, and streambed sediments. In addition, other sources of contaminants, such as historic mining operations in other tributaries, could also have affected the distribution of contaminants in the Clark Fork River basin to a limited degree. Sources of these contaminants are described below, along with the overall characteristics of the various media at this OU.

5.4.1 Tailings Residuals and Impacted Soils

Tailings residuals may be generally visually identified by color in the Clark Fork River floodplain as yellow, orange, and tan fine sandy silt to silty sand. In some areas, known as slickens, the tailings residuals are generally unvegetated, and a white to blue colored mineral salt crust may form and then accumulate at the surface at certain (usually dry) times of the year. These soluble metallic salts can be washed into the river during periods of thunderstorms, causing pulse events that lower the pH in areas of the river and, at the same time, increase the metals concentration.

In most places, tailings residuals are mixed with or are covered with a thin layer of light brown soil material that occasionally supports vegetation. Exposed and buried tailings almost always overlie an historic, buried, organic-rich soil horizon. Soil data used in the *Ecological Risk Assessment* were in a depth interval of 0 to 2 feet because most plant species have roots within this zone and burrowing mammals are more likely to be exposed in this zone. The following conclusions were based on the *Remedial Investigation* sampling results:

- The concentration of each metal of concern is highly variable in different soil samples. Within a soil type category (exposed tailings, buried tailings, cover soil, and buried soil), a two orders of magnitude difference can exist between the minimum and maximum concentrations.
- Among soil type categories, metal concentrations decrease from upstream to downstream and from riparian areas to uplands.
- The widest variation in soil pH, from 3 to 9, is exhibited throughout the historic floodplain in Reach A.

5.4.2 Groundwater

Groundwater is a pathway for migration of contaminants in the Conceptual Model, and sampling has revealed low concentrations of metals in groundwater. The limited available data, collected during the *Remedial Investigation* and used for human health risk assessments, suggest that elevated metals and arsenic concentrations in groundwater are generally restricted to within the top few feet of the shallow water table in localized areas near tailings deposits. According to the *Feasibility Study*, arsenic concentrations in waters from 11 percent of all wells (domestic and non-domestic uses) were above the Montana dissolved groundwater standards of 18 micrograms per liter (μg/L). Each of these samples were within 8 feet of the ground surface. According to the *Feasibility Study,* exceedances of the State's standards were observed in 5 percent of the samples for cadmium, lead, and zinc. No exceedances were found for copper. No samples exceeding Montana Water Quality Act standards were found below 22 feet of the ground surface.

The final groundwater arsenic standard for this *Record of Decision* is 10 μg/L, based on the recently promulgated Federal Safe Drinking Water Act standard. This likely expands the boundaries of the areas of concern for shallow groundwater contamination. Applying the new arsenic standard to the results of the 76 domestic wells that were sampled in 1987 (CH2M HILL et al. 1991) illustrates an exceedance in 5 percent of the domestic wells. That is, water from four of the sampled domestic wells would have exceeded the new arsenic standard. Arsenic concentrations in water samples from these wells were determined at 12, 13, 15, and 42 μg/L. Although in-situ treatment may mobilize arsenic into groundwater, EPA believes that the removal of slickens areas, increased vegetative cover, and decreased percolation rates will lead to groundwater compliance within a reasonable period of time.

5.4.3 Surface Water

The *Remedial Investigation* and the *Ecological Risk Assessment* concluded that concentrations of contaminants are higher in the Clark Fork River than in the reference streams and are often above State water quality standards, especially for copper and arsenic. Also, the concentrations of metals and arsenic in river water are higher in Reach A and decrease in downstream reaches, primarily because of dilution by tributary streams. Contaminants are supplied to the river as streambank tailings and contaminated sediments are eroded into the river. Also, water quality may change dramatically in response to storm events and overbank flows.

5.4.4 Streambed Sediments

The streambed sediments of the Clark Fork River are primarily coarse-grained with less than 5 percent of the streambed sediment in riffle areas consisting of silts and clays (less than 0.063 millimeters diameter). Extensive data have been collected on contaminant concentrations in Clark Fork River bed sediments. Concentrations of contaminants vary considerably based on location and time. This variability is caused by streambed erosion and deposition of streambed material that occurs naturally. Generally, metal and arsenic concentrations are three to five times higher in the finer fractions of the sediments than in the bulk fractions. Sediments from riffle areas were also investigated, and concentrations of metals were found to be 30 to 40 percent lower in these areas than in depositional areas, as expected. Also, copper concentrations in streambed sediment decrease as grain size increases.

5.4.5 Historically Irrigated Fields

Based on historic records, approximately 14,600 acres of land within the Clark Fork River OU were estimated to have been irrigated with Clark Fork River water. As reported in the *Feasibility Study*, investigations identified 120 acres of historically irrigated land that had lower vegetation cover, impacted vegetation communities, and metals- and arsenic-enriched soils that are generally acidic. Irrigated lands are often located outside the 100-year floodplain. The remaining irrigated acreage was found to have no vegetation impact discernible from aerial photo interpretation and soils sampling and analysis. Portions of the 120 acres of irrigated land had been subdivided into nominal 5-acre residential lots with homes (Eastside Road, Deer Lodge). A TCRA to protect human health of residents whose yards were contaminated was partially implemented to reduce arsenic concentrations to acceptable levels. The contaminated soils around residences were removed and transported to an offsite disposal repository, or in some cases re-incorporated into pasture soils, and the residential sites were backfilled with clean soils and revegetated. In addition, the vegetation and soils on properties adjacent to the residential areas (used primarily as pastures), which were also impacted by metals levels and low pH resulting in phytotoxic conditions, were remediated by in-situ methods. Appropriate lime additions were made to the soils to assure neutralization. Properties were then deep plowed using several passes to mix the lime with the soils up to 2 feet deep. Confirmation sampling was conducted to ensure that the response action was effective. Planting of appropriate seed mix and vegetation completed the process. The response action was effective for historically irrigated lands of participating landowners (some follow-up maintenance work is required). At least three residences with likely impacted soils refused access to conduct sampling or to work on their lands. These impacted lands will be cleaned up and other re-vegetation and operation and maintenance issues will be addressed under the post-*Record of Decision* remedial action.

In addition, two demonstration projects involving portions of pastures at two other nearby locations, again having impacted vegetation because of phytotoxic soils as a result of historical irrigation practices, were remediated by similar in-situ techniques. Again, confirmation sampling and analysis and ongoing vegetation monitoring have generally confirmed that remediation goals were met. These areas are currently undergoing monitoring and maintenance activities, which will be continued under this *Record of Decision*.

Other lands possibly impacted by past irrigation may be identified as this *Record of Decision* is implemented in Reaches A and B.

5.4.6 Biological Resources

5.4.6.1 Terrestrial Resources

Terrestrial resources have been studied most intensively in the riparian zone. Common trees in the Clark Fork River OU include black cottonwood, quaking aspen, and rocky mountain juniper. Common shrubs are water birch, snowberry, sandbar willow, booth willow, Bebb willow, and woods rose. Thirty-six other shrubs are present, but occur less frequently. Redtop, tufted hairgrass, baltic rush, smooth brome, and quackgrass are the most common grasses. Alfalfa, clover, Canada thistle, leafy spurge, spotted knapweed, and common silverweed are common broad-leafed plants. Noxious weeds are present throughout the valley, but are particularly prevalent in Reach C. Slickens areas support little vegetation, but occasionally are sparsely populated by hardy, metals-tolerant pioneer plants, such as tufted hairgrass and redtop. Metals are found at elevated concentrations in plant tissues, and concentrations of these metals vary by plant type. The highest concentration occurred in tufted hairgrass and willows. Riparian polygon health ratings from the University of Montana show gradual improvement in ratings in the downstream direction. Most of the floodplain within Reach A is currently comprised of riparian pastures for livestock and hayfields, which in their present condition are not as productive as they might be absent phytotoxic conditions.

Land use is a significant factor influencing the presence of terrestrial fauna. Livestock frequently occupy the habitat along the Clark Fork River. A portion of the riparian corridor in Reach C is occupied by roads and a railroad. However, the area supports at least 86 bird species and 23 mammal species.

5.4.6.2 Aquatic Resources

As a result of suspected impacts from mining related contamination, aquatic resources have been a focus of numerous studies and surveys. The aquatic macrophyte canopy covers 5.5 percent (Reach A) to 1.2 percent (Reach C) of the channel bottom, and is dominated by white water-crowfoot and fennel-leafed pondweed. Benthic macroinvertebrates are generally abundant in the upper Clark Fork River and include filter-feeding caddisflies, mayflies, stoneflies, blackflies, and other invertebrates. However, some "less metal tolerant" species are reduced in the upper reaches. Six species of salmonids, including bull trout (protected under the Federal Endangered Species Act [ESA]), four species of minnows, three species of suckers, several types of sunfish, and sculpins inhabit the Clark Fork River. Coarse scale and longnose suckers contribute the largest fraction of total fish biomass. Brown trout and mountain whitefish make up a significant portion of the total biomass in Reach A. State studies show trout populations are significantly depressed compared to reference streams in Montana (Lipton et al. 1995a).

5.4.7 Air Resources

Contaminants of concern (COCs) could potentially be carried by the wind under certain conditions. Although no direct data are available to quantify airborne transport of contaminants, historic air quality monitoring in Deer Lodge suggest airborne transmission is not a significant pathway for metals and arsenic transport. Dust and contaminant control during remedial activities is an important concern. ARARs that require dust control and that address this pathway will be implemented during construction.

5.5 Extent of Contamination

Exhibit 2-8, *Estimated Quantities of Exposed and Buried Tailings, Cover Soil, and Buried Soil*, shows the extent of contamination in Reach A and Reach B. No visually identified tailings have been observed in Reach C, so this reach is not included on the exhibit. This exhibit was taken from the *Remedial Investigation* and is based on 1996 data. Several investigation methods were used to estimate the extent of contamination.

During the *Remedial Investigation*, approximately 156 acres of exposed tailings and 3,339 acres of buried tailings were estimated in Reach A. In the *Feasibility Study*, the number of acres of exposed tailings in Reach A was estimated to be 167 using aerial photography and geographic information system (GIS) mapping techniques (actual acreage could be as high as 250 acres). Tailings deposits range in thickness from less than 1 inch to 34 inches. Since 1996, response actions, and demonstration projects, have been conducted within Reaches A and B. Exhibit 2-9, *Estimated Quantities of Exposed and Buried Tailings, Cover Soil, and Buried Soil With and Within Demonstration Projects*, shows the extent of treated and untreated tailings in the floodplain. The total volume of tailings in Reach A is approximately 7.6 million cubic yards. Reach B is estimated at 1.6 million cubic yards.

EXHIBIT 2-8
Estimated Quantities of Exposed and Buried Tailings, Cover Soil, and Buried Soil

				Volume (cubic yard)[2]		
Reach	**River Gradient**	**Media Division**	**Area (acres)**	**25th percentile**	**50th percentile**	**75th percentile**
A[1]	Low	Exposed tailings[3]	167	306,300	358,000	403,300
A[1]	Low	Buried tailings[3]	3,339	1,713,000	2,498,900	3,098,000
A[1]	Low	Cover soil	3,339	1,011,300	1,067,500	1,460,400
A[1]	Low	Buried soil[5]	3,494	3,758,600	3,758,600	3,758,600
Total Reach A[1]				**6,789,200**	**7,683,000**	**8,720,300**
B[6]	Low	Exposed tailings[4]	14	33,500	33,500	33,500
B[6]	Low	Buried tailings	780	174,300	300,700	419,300
B[6]	Low	Cover soil	780	343,800	343,800	439,300
B[6]	Low	Buried soil[5]	794	854,000	854,000	854,000
B[6]	High	Exposed tailings	0	0	0	0
B[6]	High	Buried tailings	47	6,300	12,600	19,000
B[6]	High	Cover soil	47	29,700	31,200	39,000
B[6]	High	Buried soil[5]	47	50,500	50,500	50,500
Total Reach B[6]				**1,492,100**	**1,626,300**	**1,854,600**

[1]Areas and volumes for Reach A include extrapolation based on air photos. Reach A exposed tailings areas and volumes reflect only those areas large enough to have been mapped individually in the *Remedial Investigation* and/or the *Feasibility Study*. Additionally, approximately 35 acres of exposed tailings exist in Reach A as “spot” tailings too small to have been mapped individually.

[2]Volumes calculated by summing the 25th, 50th, and 75th percentile thickness for each thickness class.

[3]Mean thickness value used for all volume estimates for tailings greater than 24 inches because of the small number of observations (n=5).

[4]Mean thickness (18 inches) for the depth class 12-24 inches is used for 25th, 50th, and 75th percentile because n=1.

[5]Eight-inch thickness value used for buried soils based on decrease in total copper concentration with depth.

[6]Volumes for Reach B reflect only those portions of the reach which were mapped.

Volumes are estimated as in-situ quantities.

Sources: 1) *Remedial Investigation* (Atlantic Richfield Company 1998), Table 3-4. 2) *Feasibility Study Report* (Atlantic Richfield Company 2002), Appendix D.

EXHIBIT 2-9
Estimated Quantities of Exposed and Buried Tailings, Cover Soil, and Buried Soil With and Without Demonstration Projects

	Reach A		Reach B	
Tailings and Soil Class	**Area (acres)**	**Volume (cubic yards)**	**Area (acres)**	**Volume (cubic yards)**
Without Demonstration Project Areas				
Exposed Tailings	132	271,000	14	33,500
Buried Tailings	3,075	1,882,000	828	292,000
Cover Soil	3,075	951,000	828	413,000
Buried Soil	3,208	3,450,000	842	906,000
Subtotal	*NA*	*6,554,000*	*NA*	*1,644,500*
With Demonstration Project Areas				
Treated Tailings/Impacted Soils	101	416,440	NA	NA
Untreated Tailings	263	349,000	NA	NA
Untreated Cover Soil	263	88,800	NA	NA
Untreated Buried Soil	263	283,000	NA	NA
Subtotal	*NA*	*1,137,240*	*NA*	*NA*
Total	**NA**	**7,691,240**	**NA**	**1,644,500**

Notes:

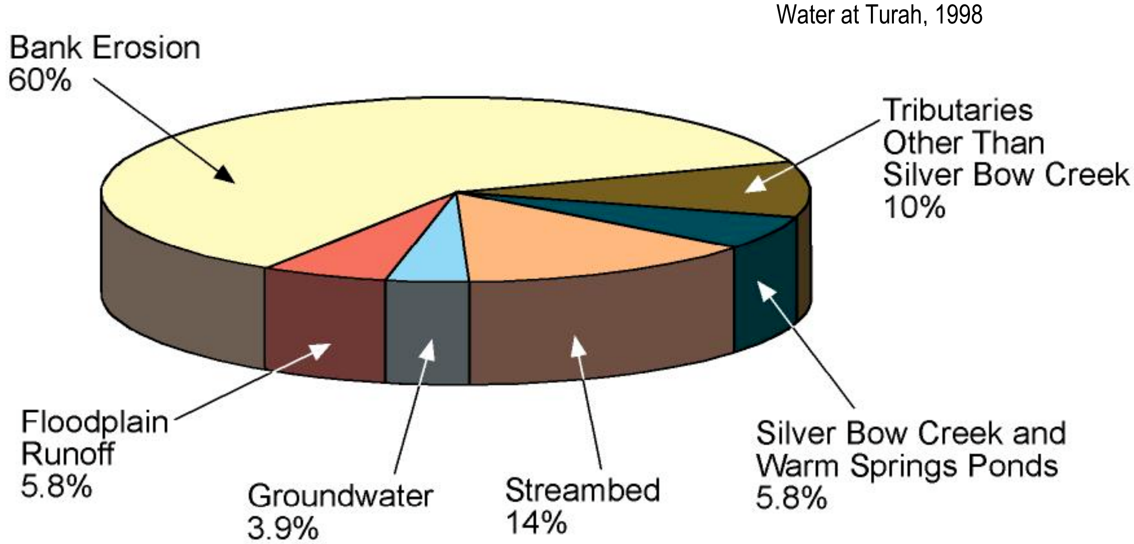
1. Demonstration Project Areas include the Governor's Demonstration Project, the Resource Indemnification Trust Demonstration Project, and the South Deer Lodge Entryway Improvement Project.
2. Reach A exposed tailings areas and volumes reflect only those areas large enough to have been mapped individually in the *Remedial Investigation* and/or the *Feasibility Study*. Additionally, approximately 35 acres of exposed tailings exist in Reach A as "spot" tailings too small to have been mapped individually. These "spot" areas and volumes were mapped as inclusions within the buried tailings areas.
3. Areas were queried directly, and volumes were calculated by multiplying the queried area by the midpoint of the thickness class for tailings and cover soil.
4. The thickness of the buried impacted tailings was taken to be 8 inches, which is the depth below tailings at which an order of magnitude drop in copper concentration typically occurs in both Reach A and Reach B.
5. Demonstration Project Area tailings, cover soils, and buried soils were treated with lime amendment, tilled, and revegetated unless overlain by existing good vegetation cover.

Sources: 1) *Remedial Investigation* (Atlantic Richfield Company 1998), Table 3-4. 2) *Feasibility Study Report* (Atlantic Richfield Company 2002), Appendix D.

5.6 Fate and Transport

As previously noted, a mass-balance model was used to quantify loading of total copper from the floodplain to the fluvial system. Copper was chosen as an indicator for this study because it is representative of mining and smelting wastes, highly toxic to aquatic and terrestrial receptors, and has the largest and most consistent data set. Model methods and results were included in the *Remedial Investigation* and a USGS report (Smith et al. 1998). The model predicted inputs during normal flow events. The results of the model indicate that streambank erosion is the largest source of total recoverable copper to the river, comprising approximately 60 percent of the total copper input along the 120-mile OU river reach, as shown on Exhibit 2-10, *Sources of Copper to Surface Water at Turah, 1998*. Tributaries and combined surface water runoff and groundwater inflow account for about 10 percent each, and upstream sources account for 6 percent of the total. The streambed accounts for approximately 14 percent of the total input. The mass balance also indicates that under current conditions, only about 56 percent of the average annual copper input to the river is transported past Turah Bridge (farthest downstream point of Reach C). The rest is deposited on point bars along the Clark Fork between Warm Springs Ponds and Turah Bridge.

EXHIBIT 2-10
Sources of Copper in Surface
Water at Turah, 1998



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6 Current and Potential Future Land and Water Uses

The total population within or adjacent to the Clark Fork River OU is approximately 16,240 people (U.S. Census Bureau 2000). Approximately 28 percent (4,500) of the total population lives in or near Reach A (the Deer Lodge Valley) between Warm Springs and Garrison. Major population centers within the Deer Lodge Valley are located at Galen, Dempsey, Montana State Prison, Deer Lodge, and Garrison. Approximately 89 percent of the land within Reach A of the Clark Fork River area is privately owned, with the remaining 11 percent managed by Federal and State agencies. The City of Missoula, with a population of 57,000, lies approximately 7 river miles downstream of the OU.

The entirety of the Clark Fork River OU is contained within the aboriginal territory of the Confederated Salish and Kootenai Tribes, who claim an ownership interest in natural resources in the OU based on the Hellgate Treaty of 1855. Lands within the Clark Fork River OU are subject to certain treaty-reserved uses by members of the Tribes.

6.1 Current and Anticipated Future Land Uses

The primary land use in the Deer Lodge Valley is agricultural. The income from agriculture is a significant portion of the total income for Powell, Deer Lodge, and Granite counties. Ranching (raising livestock) provides the significant source of the agricultural income in the Deer Lodge Valley, supplemented by the raising of certain crops. Hay is the major irrigated crop and is used locally to support the livestock industry. The high terraces on either side of the Clark Fork River valley are primarily dryland-farmed. Property without river frontage or surface water rights is commonly used as rangeland. The National Forest surrounding the Clark Fork River OU is used as summer range for livestock.

In addition to agricultural land uses, various private and public recreational land use areas exist along all three Clark Fork River reaches. These include Arrowstone Park near Deer Lodge, private campgrounds, a wildlife management area, a national historic site, fishing access points, a State recreation area, highway rest areas, and other non-designated areas, such as the trestle area in Deer Lodge. According to Montana Fish, Wildlife, and Parks (MFWP), use of the river and riparian corridor for fishing, camping, and floating is increasing (MFWP 2003). Some residential use occurs in historically irrigated properties, primarily in the Eastside Ditch area. There is some potential for future residential use in this area as well, although the primary use is agricultural.

The State of Montana and the counties of Deer Lodge and Powell regulate land use and building activities in the 100-year floodplain. Deer Lodge, Powell, and Granite counties have adopted floodplain regulations mandated by the State and based on minimum requirements specified by State statute (Montana Codes Annotated [MCA] § 76-5-201 *et seq.*). Regulations in these counties provide for creating floodplain, floodway, and floodway fringe districts. Certain activities are prohibited in the floodplain, such as building residential structures, and many uses in the floodplain require a permit, except for agricultural uses. Although new residential structures are prohibited in the floodplain, some residential uses, such as yards, are not prohibited.

Future land use was assessed by contacting the planning offices in Deer Lodge, Powell, and Granite counties. The counties confirmed that the end land use—both current and future—is agricultural or recreational. Overall, local land uses are not expected to change significantly during the next 20 years in these counties within the Clark Fork River OU.

In Deer Lodge County, rural agricultural growth and associated development is expected to remain stable. The intent of the *Anaconda Deer Lodge County Comprehensive Master Plan* is to encourage growth in existing developed areas and away from agricultural operations. The county plan also includes provisions for creating open space uses, including a greenbelt, in the Clark Fork River OU (Anaconda-Deer Lodge County 1992).

Similarly, Powell County has zoned much of the Clark Fork River OU (Reach A) within its county boundary as Agricultural Districts 3 and 4, except for the community centers of Goldcreek and Garrison and the City-County Planning Area at the town of Deer Lodge. Agricultural District 3 encompasses the area north of the Clark Fork River downstream of Garrison. Agricultural District 4 includes both the east and west sides of the Clark Fork River upstream from Garrison. The future land uses in both districts promote agricultural operations and other related activities. Residential development is discouraged in Agricultural District 3; if allowed, the density would be low. Agricultural District 4 can accommodate residential development, but only if it is consistent with and does not have negative consequences for agricultural operations (Powell County 1996).

As noted previously, some limited, historically irrigated areas near Deer Lodge are or may be residential. Most of the historically irrigated areas are likely to remain agricultural.

6.2 Groundwater and Surface Water Uses

The principal, current source of groundwater used by humans in the Clark Fork River OU is an unconfined aquifer located in unconsolidated and semi-consolidated alluvium along the valley floor. Depth to groundwater varies from near zero to more than 150 feet. Groundwater generally flows to the north-northwest, following the river valley. A well inventory conducted in 1987 (CH2M HILL et al. 1991), identified more than 500 wells within and directly adjacent to the Clark Fork River floodplain. The well inventory was not all inclusive, but the following types and numbers of wells were identified: domestic, 438; irrigation, 22; stock, 19; public supply, 22; and unused, 37. Water samples from 76 domestic wells that met specific criteria were collected and analyzed for specific physical and chemical constituents. The arsenic water standard (18 μg/L) was exceeded for one well, revealing a concentration of 42 μg/L. Re-examination of the 1987 survey data indicates waters from four wells within the OU would exceed the most recent Federal drinking water standard (10 μg/L) for human consumption.

The State has classified all groundwater within and near the OU as a potential drinking water source. Groundwater contamination generally extends only to 10 feet. Based on the State's classification of the groundwater, there is the potential use of shallow groundwater that would pose a threat (this is documented in the *Human Health Risk Assessment*). There is also the potential that shallow groundwater contamination could be drawn deeper if extensive groundwater development occurred and the shallow contamination was unaddressed.

Surface water from the river is used mainly for irrigation, with numerous withdrawal points along the river. Most of this water is used for production of hay for livestock. The river is also used for recreational purposes, with numerous points of public access for fishing, camping, and general public recreation. Surface water uses are not expected to change significantly. The State of Montana has classified the uses for the Clark Fork River as drinking water, culinary, agricultural, and fishery propagation.

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7 Summary of Site Risks

7.1 Human Health Risks

The Clark Fork River *Human Health Risk Assessment* (EPA 1998a) evaluated the likely scenarios for human exposure to the contaminants of concern for the Clark Fork River OU. Arsenic in soils and tailings is the primary concern for human exposures at this site. In order to assess and manage risks where arsenic is present in soils, EPA developed Risk Concentration Levels (RBCs). RBCs for arsenic are presented in Exhibit 2-11.

EXHIBIT 2-11
Arsenic RBCs

Land Use	Concentration
Residential	150 ppm
Recreational	680 ppm (children at Arrowstone Park and other recreational scenarios)
	1,600 ppm for fishermen, swimmers and tubers along the river
Rancher/Farmer	620 ppm

Source: 1) EPA 1998a. 2) EPA and ATSDR 2001.

The *Human Health Risk Assessment* provided text to help interpret the RBCs and states that "RBC values should be interpreted by comparison to concentration values which represent the arithmetic mean and/or UCL (upper confidence level) of the mean of a chemical averaged over an appropriate exposure unit and should not be interpreted as a 'not-to-be-exceeded' value on a sample-by-sample basis."

If an exposure area has an average arsenic-in-soils concentration that is less than the RBC for a particular use, then EPA considers the risks to be within an acceptable range and no cleanup action is proposed. In contrast, EPA found several residential yards and horse pastures south of Deer Lodge where average soil arsenic concentrations where higher than the RBCs for residential use. These risks were deemed unacceptable, and a cleanup of most of these soils was conducted where landowners granted access as part of the Deer Lodge Valley Irrigated Lands TCRA. The remaining components of that response action will be part of the selected remedy.

The following is a summary of the major findings of the *Human Health Risk Assessment (*1998*)*:

- Arsenic is the chemical of principal concern for human health in tailings, mixed tailings, and soils located along the Clark Fork River. Other mining-related elements pose no unacceptable human health hazard or risk at the concentrations found within the OU.
- If people were to live in areas where they have repeated (daily) contact with tailings, especially in Zone 1 of Reach A, risks from arsenic could be in a range of concern for both noncancer effects and for cancer effects. Zone 1 was defined in the Baseline Human

Health Risk Assessment as a relatively narrow strip of land adjacent to the river. Aerial and land surveys evaluated during the risk assessment indicated that no permanent residences were located in Zone 1 of Reach A. In remedial design, more detailed residential use survey information may be considered.

- Residential areas in Deer Lodge, including areas within the floodplain, were systematically sampled. Estimated risks for those residences did not exceed levels of concern for residential use. ATSDR did a health survey for the area that did not show elevated levels of arsenic in participating residents of Deer Lodge. The reasonably anticipated land use for this area is agricultural, and the Selected Remedy provides for institutional controls (ICs) to prevent future residential development in Zone 1 and other portions of the floodplain in Reach A.
- For people who have only intermittent or occasional contact with tailings (recreational visitors who hike along the river, swimmers who raft down the river, and hunters or fishermen along the river), arsenic levels in tailings and contaminated soils do not result in unacceptable non-cancer or cancer health risks.
- Fields or pastures that were historically flooded or irrigated with highly contaminated river water may contain arsenic levels that are unacceptable for residents if their homes are located directly in areas of high impact. These same fields do not appear to pose an unacceptable risk to farmers or ranchers because their exposure to the soils is limited in terms of time and frequency and the level of contamination is below the agricultural action level.
- Arsenic levels in all but four domestic wells are below the proposed State and current Federal drinking water standards of 10 µg/L. The wells were completed in the shallow water table, and were sampled in June 1987. The wells were located in Deer Lodge, Montana, and are to be re-sampled as part of the Selected Remedy.
- Arsenic levels in locally produced beef, fish from the Clark Fork River, and in waterfowl from the Warm Springs Ponds (located at the head of the river), are within the normally acceptable risk range.
- Arsenic levels in surface water of the Clark Fork River do not pose unacceptable human health risks for people who wade or swim in the river.
- Direct bio-monitoring of arsenic levels in urine and hair of 60 area residents did not detect unacceptable levels. The bio-monitoring for arsenic was conducted in 1997 and 1998 by the ATSDR.

Since the *Human Health Risk Assessment* was released, a local public park (Arrowstone Park) was developed in Deer Lodge. This park has different use patterns than those evaluated in the *Human Health Risk Assessment.* As a consequence, EPA and ATSDR prepared a *Human Health Risk Assessment Addendum* for recreational visitors at Arrowstone Park (2001) that focused on characterizing chronic arsenic exposure to children aged 1 to 10 years old visiting Arrowstone Park up to 48 times per year. A chronic RBC for arsenic in soil of 680 ppm for child recreational users was determined. Concurrently, the ATSDR concluded that the existing data for the park did not adequately characterize park conditions and recommended further sampling and analysis of soils for arsenic concentrations. A team from ATSDR collected soil samples from several areas within the park that represented different exposure units in 2001. EPA and ATSDR subsequently prepared the *Human Health Risk Assessment* addendum to evaluate potential and current exposures to children. Conclusions of this work (EPA and ATSDR 2001) were as follows:

- The two developed subareas (1 and 2) in Arrowstone Park were determined by EPA and ATSDR to be safe—that is, they did not pose an unacceptable risk, assuming chronic exposures as described in EPA's *Human Health Risk Assessment Addendum* for children 1 to 10 years old who visit the park up to 48 times per year for many years.
- There is no concern at present for undeveloped subareas (3 and 4) of the park, since arsenic levels and/or use are low.
- The sampling effort was designed to characterize risk of chronic exposure to arsenic in soils of the park—the data cannot be used to assess risk from acute arsenic exposures to children who may eat contaminated soils.

The ATSDR report also made the following recommendations (EPA and ATSDR 2001):

- If subareas 3 and/or 4 are developed, ATSDR recommends further arsenic sampling and/or cleanup.
- ATSDR recommends that Powell County proceed with its efforts to educate parents about the risks to children from eating soil.

In public comments of EPA's *Proposed Plan*, ATSDR identified the trestle area near Deer Lodge as an area that likely presented current unacceptable risks to recreational users. EPA will conduct additional sampling of this area as needed to supplement existing data. If recreational levels are exceeded, remedial actions will be implemented.

The NPS conducted a *Human Health Risk Assessment* for the Grant-Kohrs Ranch National Historic Site (NPS 2003). This risk assessment is generally consistent with EPA's *Human Health Risk Assessments*. However, the NPS risk assessment did find risks within a range of concern to workers from sediment associated with the irrigation ditches at the ranch. This risk exists even if the NPS risk assessment is adjusted by using site-specific bioavailability assumptions developed by the Atlantic Richfield Company. This exposure scenario is not unique to the Grant-Kohrs Ranch National Historic Site. Additional sampling will be performed, on an as needed basis in suspect irrigation ditches in other areas of the OU as part of remedial design, to determine if unacceptable risks are present, and, if so, how the risks can be mitigated. This aspect of the Selected Remedy is described in Section 13.8.3, page 2-119.

Shallow groundwater along the river corridor (but generally not under historically irrigated lands) is contaminated with metals and arsenic. Isolated areas of shallow groundwater contain contamination above the Federal standard of 10 μg/L. If shallow wells (25 feet or less) are developed within the floodplain in these areas, for domestic purposes, unacceptable human health risks could result because of arsenic contamination.

The overall conclusion that human health risks are generally low along the river is not because the contaminants are without the potential for causing harmful effects, but because human exposures to contaminants along the near-river corridor are low. Risks could be in a range of concern if permanent residences were maintained within the active floodplain.

There, arsenic concentrations in soils and tailings, as well as in shallow groundwater, often exceed acceptable levels for residential exposure (several hours of contact every day for many years). In addition, risks could be in a range of concern where residences have been constructed on lands that were historically irrigated with Clark Fork River water. EPA believes that the practicing of traditional cultural activities by members of Native American tribes in the floodplain may result in exposures similar to those expected from taking part in recreational activities.

7.2 Ecological Risks

The *Ecological Risk Assessment* established clear risks to the terrestrial environment along Reach A of the Clark Fork River OU. Limited risks were identified for Reaches B and C. Exposed tailings generally lack vegetation and impacted soils and vegetation areas sustain reduced terrestrial plant species diversity and cover. This unacceptable risk is particularly important to some landowners within the Clark Fork River OU. The geomorphic studies and evaluations have emphasized this risk by noting that the Clark Fork River suffers from excessive erosion and loss of land and by hypothesizing the potential for river unraveling in a severe flood event. While many of the erosional aspects of this geomorphic evaluation are documented in the geomorphology reports and understood, significant uncertainty is associated with the hypothesized floodplain unraveling risk.

Surface water runoff from barren slickens or impounded water on barren slickens can contain very high concentrations of contaminants. Maximum concentrations in runoff water from barren slickens were reported to be 7,380 mg/L copper, 2,350 mg/L zinc, and 23 mg/L arsenic (Atlantic Richfield Company 1997). Because of the high level of contaminants in runoff from bare slickens, EPA made screening level calculations of acute risk to wildlife (birds and mammals, including cattle) from ingestion of surface runoff water. Results presented in the *Ecological Risk Assessment* (EPA 1999) indicated that under these maximum concentration conditions of contaminants in surface runoff waters, ingested doses might be of acute concern to birds and even large mammals.

According to EPA's *Ecological Risk Assessment*, historic impacts of mine waste on the Clark Fork River were severe. The report indicates "essentially no fish existed in the upper Clark Fork River dating from the late 1800s into the 1950s." Fish populations began to re-establish to some degree after construction of the third Warm Springs sediment pond in 1959, and a new water treatment system for mine water discharge was installed in Butte between 1972 and 1975 that resulted in improved water quality. Documented fish kills, however, continued as late as 1991 and State studies show a significantly reduced trout population.

The *Ecological Risk Assessment* evaluated several factors and investigation results relating to chronic risks to Clark Fork River aquatic macroinvertebrates and fish. The State also submitted a study during the public comment period that demonstrated harmful chronic effects on fish from arsenic exposure. The data from these studies are consistent with the hypothesis that copper concentrations (and possibly arsenic and other metals) in the aquatic environment (surface water, diet) impose low-level chronic stress on aquatic macroinvertebrates, trout, and other fish. The most likely manifestation of this stress is decreased growth. It is unknown to what degree this chronic stress or an avoidance response contribute to the decrease in fish population in the river. The State believes this is an important area of risk and has produced detailed reference stream studies that indicate the Clark Fork River has six times fewer salmonid fish populations than reference streams in Montana with similar characteristics but without metals and arsenic concentrations.

EPA considers it likely that acute exposures to pulses of metals or other high-concentration events are more important than chronic stresses to both fish and other important aquatic invertebrates, since even intermittent fish kills from pulse events could lead to reductions in fish population. Such pulse events are also responsible for the intermittent fish kills that have occurred since fish populations began to re-establish in the 1950s. It is also considered likely that decreases in fish populations in the Clark Fork River may also be due in part to other factors, such as sedimentation caused by excessive erosion as a result of mining wastes. Considering all the available information, EPA has concluded that the risks to the aquatic system are unacceptable.

EPA must also give special consideration to bull trout in the Clark Fork River. Bull trout are listed as a threatened species under the ESA, and EPA has a responsibility under the National Contingency Plan (NCP) to ensure that such species are sufficiently protected through remedy selection and implementation.

Finally, the *Ecological Risk Assessment* described potential risk to wildlife along the Clark Fork River corridor. There is considerable uncertainty associated with this potential risk, and EPA is evaluating follow-up studies associated with this pathway and receptor group.

Supporting data, documenting the concentrations of metals in each medium and trout toxicity data, are provided in the remainder of this section.

The location of surface water sample sites is shown in Exhibit 2-12, *USGS Surface Water Gaging Stations Along the Mainstem of the Clark Fork River OU*. As shown in Exhibit 2-13 *Surface Water Summary Statistics (1991 to 1996)*, the maximum and median concentrations of contaminants is higher in the Clark Fork River than in the reference streams (Rock Creek, Gold Creek, Little Blackfoot River and Blackfoot River [EPA 1999]). Also, the concentrations of metals in river water are higher in Reach A and decrease in downstream reaches. Contaminants are constantly supplied to the river as streambank tailings and contaminated sediments are eroded into the river.

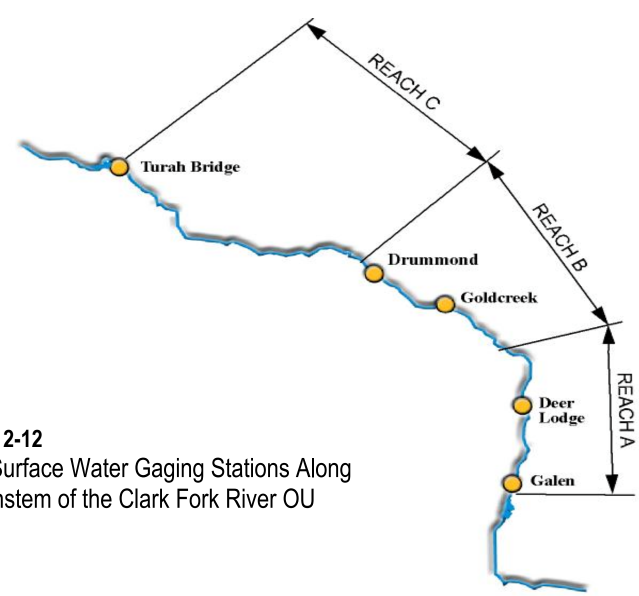


EXHIBIT 2-12
USGS Surface Water Gaging Stations Along the Mainstem of the Clark Fork River OU

EXHIBIT 2-13
Surface Water Summary Statistics (1991 to 1996)

		Concentration (µg/L)											
		Galen N=53		Deer Lodge N=52		Goldcreek N=42		Drummond N=42		Turah Bridge N=46		Reference Stream N=73	
Chemical	**Statistic**	**Tot**	**Diss**	**Tot**	**Diss**	**Tot**	**Diss**	**Tot**	**Diss**	**Tot**	**Diss**	**Tot**	**Diss**
Arsenic	Max	78.0	53.0	220.0	36.0	75.0	20.0	62.0	20.0	33.0	13.0	14.0	7.0
	Median	16.0	13.0	19.0	13.0	16.0	10.0	16.5	11.0	8.0	5.0	1.0	1.0
Cadmium	Max	1.0	0.5	5.0	0.5	2.0	0.3	2.0	0.2	1.0	0.5	0.5	0.5
	Median	0.5	0.05	0.5	0.1	0.5	0.1	0.5	0.1	0.5	0.1	0.5	0.1
Copper	Max	150.0	32.0	960.0	85.0	440.0	36.0	360.0	21.0	180.0	19.0	16.0	7.0
	Median	25.0	10.0	51.0	10.0	43.0	7.0	40.0	6.0	17.0	4.0	2.0	0.5
Lead	Max	24.0	3.0	140.0	5.0	73.0	0.6	56.0	1.2	33.0	1.0	25.0	2.0
	Median	2.0	0.3	5.0	0.3	6.0	0.3	9.0	0.3	3.0	0.3	0.5	0.3
Zinc	Max	180.0	39.0	1,100.0	50.0	510.0	26.0	490.0	21.0	270.0	22.0	50.0	24.0
	Median	50.0	11.0	60.0	11.0	50.0	8.4	65.0	7.5	30.0	6.0	5.0	1.5

Diss = Dissolved
Tot = Total
Reference Stream Summary Stats for – Rock Creek, Gold Creek, Little Blackfoot River and Blackfoot River
Source: EPA 1999. Table 4-1; data collected by USGS

Water quality changes dramatically in response to storm events. As noted, EPA's *Ecological Risk Assessment* focussed on sporadic events where rain or runoff washes metal salts from tailings and into the river (EPA 1999). Surface water quality response to each thunderstorm high flow event is unique. For example, Exhibit 2-14, *Surface Water Quality in Response to a Rainstorm Event on 7/5/94 Clark Fork River Below Warm Springs Creek*, shows that total and dissolved copper increases dramatically during a storm runoff event. This increase is variable based on the location and the amount of metal salts available at that location for runoff.

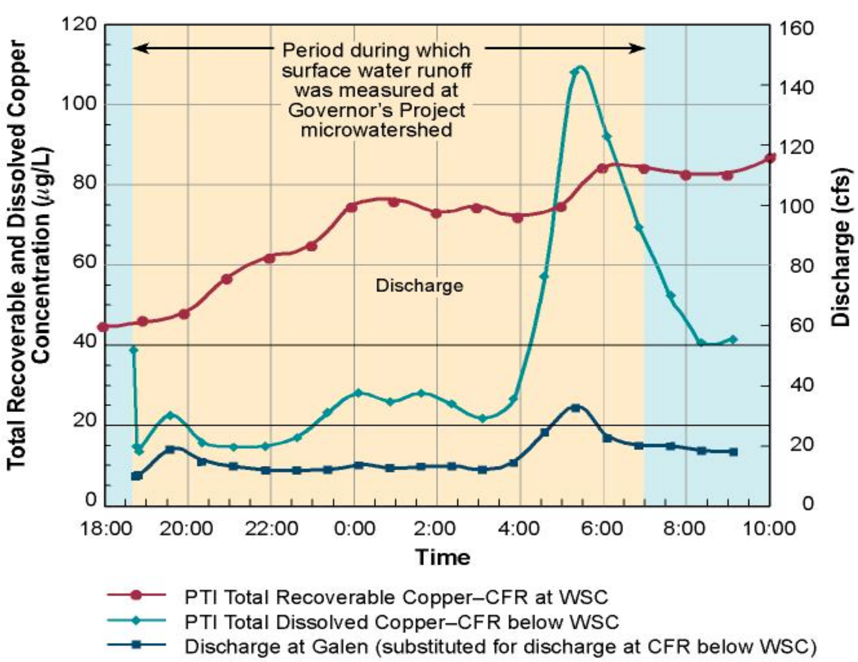
Exhibit 2-15, *Copper Concentrations (1993-1999), Total Recoverable and Dissolved*, page 2-47, presents summary statistics of the concentration of copper in surface water at various sites. This exhibit compares water samples at six locations on the Clark Fork River (Galen, Deer Lodge, Goldcreek, Drummond, and Turah Bridge) to Silver Bow Creek above the Warm Springs Ponds. The total recoverable (TR) concentrations are intended to be compared to the State's water quality standard for copper. The dissolved copper concentrations (DISS) are intended to be compared to Federal Ambient Water Quality Criteria (FAWQC). White numbers on Exhibit 2-15 exceed the given standards. Silver Bow Creek above the Warm Springs Ponds supports no fish population, and the macroinvertebrate community structure is severely impaired by metals, particularly dissolved copper.

Taken together, the data from these studies are consistent with the hypothesis that copper concentrations (and possibly arsenic and other metals) in the aquatic environment (surface water, diet) impose low-level chronic stress on aquatic macroinvertebrates, trout, and other fish. It is unknown to what degree this chronic stress or the avoidance response contribute to the decrease in standing fish population, and it is considered likely by EPA that acute exposures to pulses or other high-concentration events are more important than chronic stresses, since even intermittent fish kills from pulse events can lead to significant reductions in fish population. The State believes that chronic stress factors are more important. EPA also recognizes that aquatic life problems in the Clark Fork River OU may be due in part to other factors, such as stream embeddedness, nutrient loading, stream dewatering, channelization, increased water temperature and reduced oxygen. However, these conditions are also typical of other streams in Montana, whereas the presence of high levels of heavy metals and arsenic in the river and floodplain are not.

As noted earlier, USGS has concluded that reduced woody vegetation has produced a high risk of floodplain unraveling. The unraveling of the floodplain in a high flow event would virtually destroy the aquatic environment of the upper Clark Fork River and make any recovery extremely costly. EPA also recognizes the uncertainty associated with this view. What is clear is that the lack of vegetation already causes excessive erosion of land and generates increased sedimentation. These conditions are harmful to terrestrial health, land use, and aquatic receptors at the Clark Fork River OU.

EXHIBIT 2-14

Surface Water Quality in Response to a Rainstorm Event on 7/5/94 Clark Fork River Below Warm Springs Creek



Source: ARCO 1998.

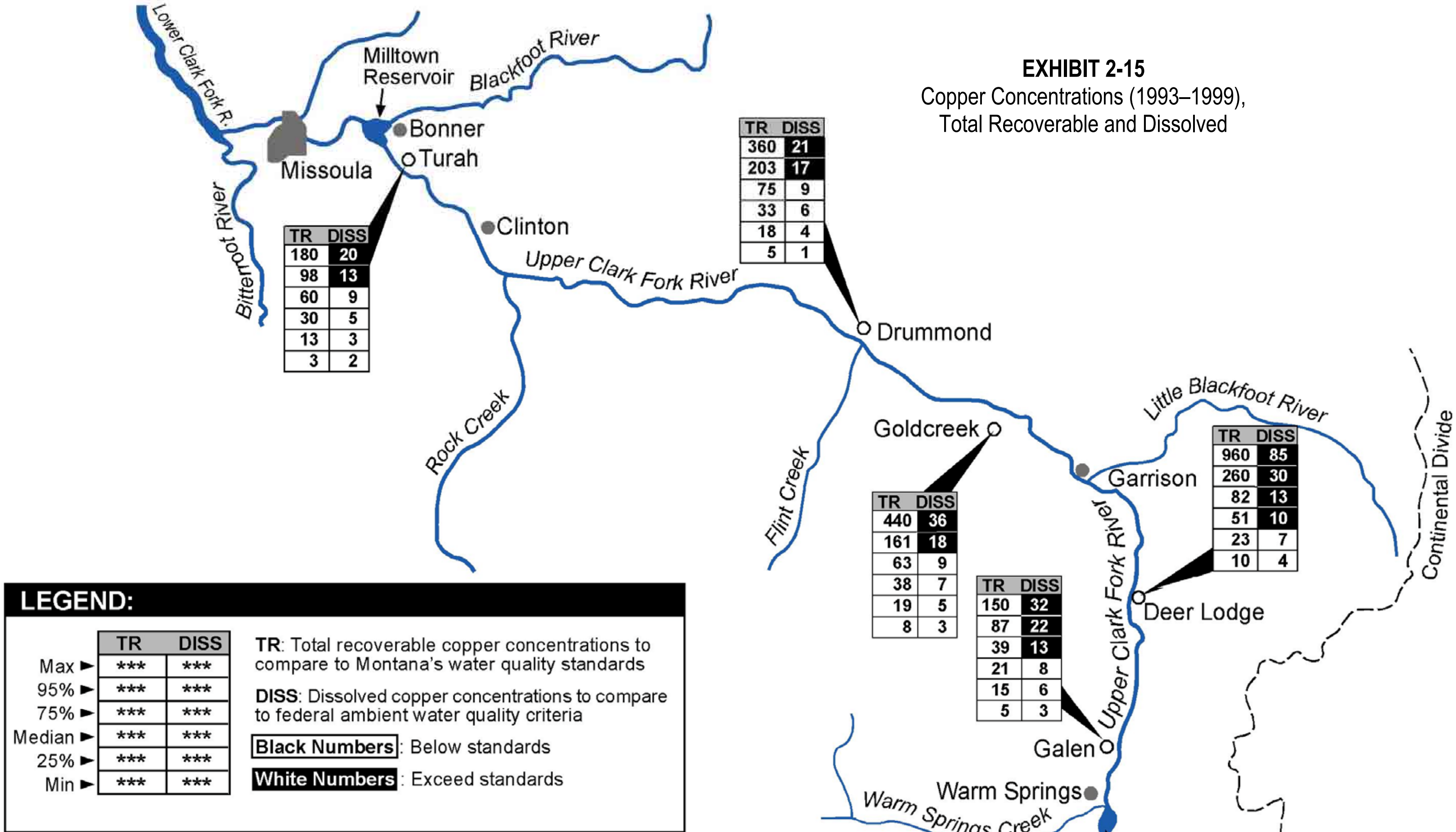
Notes: Discharge from USGS hourly flow data at Perkins Lane Bridge (CFR near Galen). This station is approximatly 2 miles downstream from Clark Fork River (CFR) below Warm springs Creek (WSC). Surface Water Runoff Period at Governor's Project is in response to the thunderstorm event.

cfs = cubic feet per second
ug/L = micrograms per liter

7.3 Basis for Response Action

Based on the entire administrative record, including the *Ecological Risk Asessment* and the *Human Health Risk Assessment* and *Addendum*, and geomorphology reports and other USGS work, EPA's conclusion is that widespread unacceptable terrestrial and aquatic risk exists in Reach A and portions of Reach B of the Clark Fork River OU. EPA, in consultation with DEQ, has determined the response action selected in this *Record of Decision* is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

EXHIBIT 2-15
Copper Concentrations (1993–1999), Total Recoverable and Dissolved



SOURCE: US Environmental Protection Agency, Region 8, Montana Office.

Water Quality Standards	TR	Diss
WQB-7	1300	
FAWQC (Acute)		13.0
FAWQC (Chronic)		9.0
TRV (Acute)		31.0
TRV (Chronic)		26.8

Notes: All values in µg/L
Hardness @ 100
FAWQC = Federal Ambient Water Quality Criteria
TRV = Trout Toxicity Reference Value

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8 Remedial Action Objectives

For floodplain tailings and impacted soils, the Remedial Action Objectives (RAOs) are as follows:

1. For human health—prevent or inhibit exposure to arsenic-contaminated soils/tailings where ingestion or contact would pose an unacceptable health risk.
2. For the environment—prevent or reduce unacceptable risk to ecological (including agricultural, aquatic, and terrestrial) systems degraded by contaminated soils/tailings.

For groundwater, the RAOs are as follows:

1. Return contaminated shallow groundwater to its beneficial use within a reasonable timeframe.
2. Comply with State groundwater standards, including nondegradation standards.
3. Prevent groundwater discharge containing arsenic and metals that would degrade surface waters.

For surface waters, the RAOs are as follows:

1. Reduce or eliminate "pulses" of metals to the river, including those caused by snowmelt and thunderstorm events.
2. Achieve compliance with surface water standards, unless a waiver is justified.
3. Prevent ingestion of, or direct contact with, water posing an unacceptable human health risk.
4. Achieve trout Toxicity Reference Values (TRVs) and acute and chronic Federal Ambient Water Quality Criteria (AWQC).
5. Comply with stormwater ARARs.

Remedial Goals (RGs) corresponding to these objectives are presented in Exhibit 2-16. The final *Human Health Risk Assessment* (1998a) and its addendum (EPA and ATSDR 2001) provide numeric goals for the protection of human health and are the basis for the soil level RGs. The RGs for surface water and groundwater based on State and Federal ARARs are shown in Exhibit 2-16.

These RGs are important performance standards for Reach A and Reach B remediation action, to be achieved site-wide after remediation is complete. These are based on State WQB-7 Standards for Surface Water, except for copper, which is waived (see Section 14.2, page 2-148). The copper standard is based on Federal water quality criteria issued by EPA under the Clean Water Act. Groundwater standards are based on State WQB-7 Standards for groundwater except for arsenic, which is based on the more stringent Federal Standard promulgated under the Safe Drinking Water Act.

EXHIBIT 2-16
Surface Water and Groundwater RGs

Metals	Surface Water (µg/L)[a]			
	Acute	**Chronic**	**Human Health**	**Groundwater (Dissolved, µg/L)**
Arsenic[b]	340	150	10/18	10
Cadmium	2	0.25	5	5
Copper[c]	13	9	1,300	1,300
Iron	-	-	-	300
Lead	81	3.2	15	15
Zinc	119	119	2,100	2,100

Notes:
[a] Based on 100 mg/L hardness, total recoverable, acute, and chronic

[b] Arsenic standard for ground and surface water is for dissolved concentrations based on the application of the Federal standard promulgated under the Safe Drinking Water Act. For surface water, the State WQB-7 standard, 18µg/l, measured as total recoverable, is applicable. Final determination of whether these standards will be consistently attained will depend on upstream source control as well as implementation of this remedy.

[c] Copper standard is for dissolved concentrations that match the Federal Aquatic Water Quality Criteria (Gold Book 1986).

The RBCs for residential, recreational, and agricultural exposure are listed below. These RBCs are for arsenic concentrations in soils, as averaged over exposure units. EPA considers acceptable exposure levels to be concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} (1 in 10,000 probability) to 10^{-6} (1 in 1,000,000 probability), with 10^{-6} as the point of departure. EPA is proposing the following arsenic concentrations, which represent a 10^{-4} excess cancer risk:

- Residential—150 parts per million (ppm)
- Recreational (non-cancer)—680 ppm (children at Arrowstone Park and other recreational scenarios), 1,600 ppm for fishermen, swimmers, and tubers along the river
- Rancher/Farmer—620 ppm

The RAOs and associated RGs and performance standards are straightforward expressions of what the remedy should accomplish at the Clark Fork River OU. They are based on the State of Montana's classification and use designations for the Clark Fork River and the groundwater aquifer along the river described earlier, and on the risk information described in Section 7, page 2-39. Protecting human health from arsenic contamination (see RAOs, previous page) at the Clark Fork River OU will address the contaminant identified by the *Human Health Risk Assessment* as the driving human concern at this site. Finding ways through the remedy to effectively and permanently address plant growth, aquatic impacts, erosion and streambank stability, and agricultural land use (see RAOs, previous page) will address the unacceptable environmental risk findings described in the previous sections of this *Record of Decision*.

9 Description of Alternatives

9.1 Remedy Components for Each Alternative

In the *Feasibility Study*, eight primary alternatives were evaluated in detail. Many of these alternatives incorporate sub-alternatives that change some aspect of their remedial performance. The sub-alternatives specify varying streambank lengths, different streambank treatments, and removal or in-situ treatment of varying estimated acreage of impacted soils. In total, 23 different approaches are evaluated, including no further action. The eight primary alternatives and sub-alternatives are described in Exhibit 2-17, *Remedy Components of Evaluated Alternatives*. The range of costs for each of the alternatives is also shown in Exhibit 2-17. The cost breakdown for each alternative, which was prepared in 2002 for the *Feasibility Study*, is provided in Exhibit 2-18, page 2-56. These costs have been updated for the selected remedy and are presented in Section 13.13, page 2-138.

The *Feasibility Study* screened out active treatment of groundwater, streambed sediment, and surface water alternatives prior to the development and detailed analysis of alternatives because EPA's preference is to address the source of contamination and because of implementability concerns. Therefore, the detailed alternatives only address solid media on the floodplain or in irrigated areas for remedial action.

The process of developing media-specific and combined-media alternatives for the Clark Fork River OU included a series of open meetings. Input was solicited from agency representatives, local governments, and members of public interest groups. Technology options for tailings and impacted soils, and eroding streambanks, were developed and assembled into eight primary alternatives. EPA approved the eight primary alternatives as the final list of alternatives to be carried into the detailed analysis of the *Feasibility Study*. Several details associated with the eight conceptual alternatives, such as estimated acreage and depth of tailings, were discussed and refined at a series of open working meetings spanning 6 months immediately prior to the release of the draft *Feasibility Study*. Generally, all alternatives except no action include the use of Best Management Practices (BMPs) or land use management activities designed to protect the remedy of the floodplain and the streambanks.

EXHIBIT 2-17
Remedy Components of Evaluated Alternatives

Description of Alternatives	Sub-alternatives
Alternative 1: No Further Action (Cost $8,782,000)—Involves no further remedial action, beyond those currently in place or undertaken. Provides the baseline conditions against which the other remedial action alternatives are compared. Evaluation required by Superfund regulations.	Not applicable
Alternative 2: In-Place Reclamation of Exposed Tailings (167 acres) (Cost $13,393,000)—In-situ reclamation of exposed tailings areas. Areas of buried tailings and impacted soils with or without impacted vegetation would not be reclaimed. These areas may be assigned "no further action," or may receive best management practices (BMPs) or land use management activities designed to enhance or allow natural recovery. Streambanks with tailings or impacted soils would be addressed with BMPs or land use management approach.	Not applicable
Alternative 3: In-Place Reclamation of Exposed Tailings and Other Impacted Soils and Vegetation Areas (Range of costs $16,369,000 - $29,310,000)—In-situ reclamation of exposed tailings and in-situ reclamation of buried tailings areas with impacted vegetation. Areas of buried tailings without impacted vegetation would not be actively remediated. These areas may be slated for no further action, or they may be addressed with BMPs or a land use management approach. Two different reclamation acreages were developed for this alternative and for Alternatives 4, 5 and 6.) The alternative was divided into 3A and 3B sub-alternatives for the two acreages. These areas differ because two different methods have been used to estimate areas of impacted vegetation.	• Alternative 3A: In-situ Reclamation of Exposed Tailings and Other Impacted Soils and Vegetation Areas (285 acres). – 167 exposed – 118 buried • Alternative 3B: In-situ Reclamation of Exposed Tailings and Other Impacted Soils and Vegetation Areas (867 acres). – 167 exposed – 700 buried
Alternative 4: In-Place Reclamation of Exposed Tailings and Other Impacted Soils and Vegetation Areas with Streambank Stabilization (Range of costs $18,897,000 - $64,504,000)— Treatment of exposed tailings and buried tailings areas with impacted vegetation (the same as Alternative 3.) Alternative 4 goes a step further by addressing certain streambanks with a combination of BMPs, land use management, or in-situ stabilization. Similar to Alternative 3, two different sub-alternative methods (4A and 4B) have been used to estimate areas of impacted vegetation. The sub-alternatives are further differentiated by four different streambank lengths identified for stabilization. Additionally, sub-alternatives 4A4 and 4B4 include a 50-foot buffer zone on each side of the active channel. Site conditions (including the presence of healthy woody vegetation) and the size and configuration of the floodplain tabs will dictate the choice and use of the following remedial activities within the riparian corridor buffer zone:	• Alternative 4A: In-situ Reclamation of Exposed Tailings and Other Impacted Soils and Vegetation (285 acres) with Streambank Stabilization. Includes 167 acres of exposed tailings and 118 acres of buried tailings with impacted vegetation. Further divided by amount of streambank treated: – Alternative 4A1: 22,367 feet of streambank. – Alternative 4A2: 72,777 feet – Alternative 4A3: 160,450 feet – Alternative 4A4: 264,000 feet plus 50-foot riparian corridor

EXHIBIT 2-17
Remedy Components of Evaluated Alternatives

Description of Alternatives	Sub-alternatives
• Maintaining the status quo for a particular section (where there is existing vegetation, particularly willows, sections of streambank will not be disturbed other than to incorporate more dense vegetation) • In-situ treatment or select removal of near-channel tailings that would not otherwise support vegetation Woody vegetation capable of developing deep binding root mass and reducing shear stress against denuded banks will be established within the corridor buffer zone.	• **Alternative 4B**: In-situ Reclamation of Exposed Tailings and Other Impacted Soils and Vegetation (867 acres) with Streambank Stabilization. Includes 167 acres of exposed tailings and 700 acres of buried tailings with impacted vegetation. Further divided by amount of streambank treated: – Alternative 4B1: 22,367 feet of streambank. – Alternative 4B2: 72,777 feet – Alternative 4B3: 160,450 feet • Alternative 4B4: 264,000 feet plus 50 foot riparian zone
Alternative 5: Removal of Exposed Tailings and In-Place Reclamation of Other Impacted Soils and Vegetation, Opportunity Ponds Disposal Option (Range of costs $36,310,000 - $84,327,000)—Removal of exposed tailings only. Tailings areas with impacted vegetation would be reclaimed in place, and areas of buried tailings without impacted vegetation would not be reclaimed, but would be addressed with BMPs or a land use management approach. Where removal of exposed tailings intercepts streambanks, those streambanks would be reconstructed. Streambanks without tailings or impacted soils would be slated for no action or for BMPs and land use management. Alternative 5 requires removal and replacement of the approximately 167 acres of exposed tailings in Reach A. Removal options, presented as sub-alternatives 5A, 5B, 5C, and 5D, include removal of tailings plus 4 inches of underlying soil or removal of tailings plus 12 inches of underlying soil. Removed tailings and contaminated soils will be transported either to the Opportunity Ponds or to a series of local repositories located outside of the 500-year floodplain. **EPA's Selected Remedy most closely resembles 5D, and adds elements from 4B4 and 6C.**	• Alternative 5A: – 167 acres of exposed tailings removed, plus 4 inches of soil – 118 acres of impacted soils and vegetation treated in place – Reconstruct 18,370 feet of streambank – Tailings transported to Opportunity Ponds • Alternative 5B: – 167 acres of exposed tailings removed, including 4 inches of soil – 700 acres of impacted soils and vegetation treated in place – Reconstruct 18,370 feet of streambank • Alternative 5C: – 167 acres of exposed tailings removed, including 12 inches of soil – 700 acres of impacted soils and vegetation treated in place – Reconstruct 18,370 feet of streambank – Tailings transported and deposited in local repositories built outside of 500-year floodplain

EXHIBIT 2-17
Remedy Components of Evaluated Alternatives

Description of Alternatives	Sub-alternatives
	• **Alternative 5D:** – 167 acres of exposed tailings removed, including 4 inches of soil – 660 acres of impacted soils and vegetation areas treated in place. – Stabilize 264,000 feet of streambank – Incorporates 50-foot buffer zone, similar to Alternative 4 (158 acres removal, 264,000 feet remediated streambank) – Disposal at Opportunity Ponds
Alternative 6: Removal of Exposed Tailings and Other Impacted Soils and Vegetation, Opportunity Ponds Disposal Option (Range of costs $48,225,000 - $110,478,000) — Alternative 6 calls for removal of exposed tailings and removal of areas of buried tailings with impacted vegetation. No in-situ reclamation is proposed under Alternative 6. Areas of buried tailings without impacted vegetation would not be actively reclaimed, but would be addressed with BMPs or a land use management approach. Where removals intercept streambanks, the banks would be reconstructed. The amount of streambank reconstruction would be greater for Alternative 6 than for Alternative 5 because the additional removals would affect more streambank locations. Alternative 6 requires removal and replacement of the 167 acres of exposed tailings in Reach A plus all areas of buried tailings with impacted vegetation. Removal acreages in Alternatives 6A and 6B differ because two different methods have been used to estimate areas of impacted vegetation.	• Alternative 6A: – 285 acres of exposed tailings and other impacted soils and vegetation removed, including 4 inches of soil below each deposit – 43,845 feet of streambank stabilized • Alternative 6B: – 867 acres of exposed tailings and other impacted soils and vegetation removed, including 4 inches of soil below each deposit – 95,000 feet of streambank stabilized • **Alternative 6C:** – 827 acres of exposed tailings and other impacted soils and vegetation removed, including 4 inches of soil below each deposit – 264,000 feet of streambank stabilized – Incorporates 50-foot buffer zone, similar to Alternative 4B4 (158 acres removal, 264,000 feet remediated streambank)

EXHIBIT 2-17
Remedy Components of Evaluated Alternatives

Description of Alternatives	Sub-alternatives
Alternative 7: Total Removal Unless Overlain by Woody Vegetation, Opportunity Ponds Disposal Option (Range of costs $161,614,000 - $179,381,000)—Alternative 7 is the near-total removal alternative that excludes removal in areas with existing woody vegetation. This alternative is intended to allow for as much removal as possible while leaving existing woody vegetation in place. Under Alternative 7, areas of exposed tailings without woody vegetation would be removed, areas of buried tailings with impacted vegetation but without woody vegetation would be removed, and areas of buried tailings without impacted vegetation or woody vegetation would be removed. Removals would occur in areas without woody vegetation within existing demonstration projects and other areas within the floodplain where tailings or metals-impacted soils were previously reclaimed using in-situ reclamation techniques. Any buried tailings and metals-impacted soil areas that have woody vegetation would be addressed with BMPs, similar to Alternatives 2 through 6, and land use management. Where removals intercept streambanks, the banks would be reconstructed. Removal would be to a depth of 4 inches below the tailings, for an estimated total volume of 3.8 million cubic yards.	• Alternative 7A: Total Removal Unless Overlain by Woody Vegetation with Removal to the Opportunity Ponds Disposal Area: – 2,483 acres removed – 131,583 feet of streambank reconstructed • Alternative 7B: Total Removal Unless Overlain by Woody Vegetation to the Opportunity Ponds Disposal Area with Streambank Stabilization and a Riparian Corridor Buffer: – 2,365 acres removed – 264,000 feet of remediated streambank – Incorporates 50-foot buffer zone, similar to Alternative 4B4 (158 acres removal, 264,000 feet remediated streambank)
Alternative 8: Total Removal, Opportunity Ponds Disposal Option (Range of costs $355,370,000 - $368,438,000)—Alternative 8 is the total removal alternative. Areas of exposed tailings would be removed, and all areas of buried tailings, with or without impacted vegetation and with or without woody vegetation, would be removed. Where removals intercept streambanks, the banks would be reconstructed as described below. Streambanks without tailings or impacted soils would be slated for no action or for BMPs and land use management, similar to Alternatives 2 through 7. Removal would be to a depth of 12 inches below the tailings, for an estimated total volume of 9.1 million cubic yards.	• Alternative 8A: Total Removal with Transport to the Opportunity Ponds for Disposal: – 3,570 acres removed – 345,000 feet of streambank reconstructed • Alternative 8B: Total Removal with Transport to the Opportunity Ponds for Disposal plus Streambank Stabilization and Riparian Corridor Buffer: – 3,412 acres removed – 264,000 feet of streambank stabilized – Incorporates 50-foot buffer zone, similar to Alternative 4B4 (158 acres removal, 264,000 feet remediated streambank)

EXHIBIT 2-18
Reach A Alternative Cost Estimate Summary

Alternative	Sub-Excavation Depth (inches)	Capital Cost (000s)	Annual Monitoring and Maintenance Cost (000s)	Miscellaneous Costs (000s)	Net Present Value (000s)
1. No Further Action	NA	—	$708	—	$8,782
2. In-situ Reclamation of Exposed Tailings (167 acres)	NA	$2,962	$742	$1,239	$13,393
3A. In-situ Reclamation of Exposed Tailings and Other Impacted Soils (285 acres)	NA	$4,853	$764	$2,038	$16,369
3B. In-situ Reclamation of Exposed Tailings and Other Impacted Soils (867 acres)	NA	$13,111	$862	$5,507	$29,310
4A1. In-situ Reclamation of Exposed Tailings and Other Impacted Soils (285 acres) with Streambank Stabilization (20,592 feet), Criteria 1	NA	$6,383	$792	$2,681	$18,897
4A2. In-situ Reclamation of Exposed Tailings and Other Impacted Soils (285 acres) with Streambank Stabilization (67,584 feet), Criteria 2	NA	$9,672	$855	$4,062	$23,348
4A3. In-situ Reclamation of Exposed Tailings and Other Impacted Soils (285 acres) with Streambank Stabilization (149,429 feet), Criteria 3	NA	$13,792	$949	$5,793	$31,359
4A4. In-situ Reclamation of Exposed Tailings and Other Impacted Soils (285 acres) with Streambank Stabilization and Riparian Corridor Buffer (298,848 feet), Criteria 4	NA	$24,879	$1,359	$10,449	$52,092
4B1. In-situ Reclamation of Exposed Tailings and Other Impacted Soils (867 acres) with Streambank Stabilization (20,592 feet), Criteria 1	NA	$14,631	$890	$6,145	$31,822
4B2. In-situ Reclamation of Exposed Tailings and Other Impacted Soils (867 acres) with Streambank Stabilization (67,584 feet), Criteria 2	NA	$17,919	$953	$7,526	$37,273

EXHIBIT 2-18
Reach A Alternative Cost Estimate Summary

Alternative	Sub-Excavation Depth (inches)	Capital Cost (000s)	Annual Monitoring and Maintenance Cost (000s)	Miscellaneous Costs (000s)	Net Present Value (000s)
4B3. In-situ Reclamation of Exposed Tailings and Other Impacted Soils (867 acres) with Streambank Stabilization (149,429 feet), Criteria 3	NA	$22,039	$1,047	$9,257	$44,284
4B4. In-situ Reclamation of Exposed Tailings and Other Impacted Soils (867 acres) with Streambank Stabilization and Riparian Corridor Buffer (298,848 feet), Criteria 4	NA	$32,801	$1,445	$13,776	$64,504
5A. Removal of Exposed Tailings and In-situ Reclamation of Other Impacted Soils (118 acres In-situ, 167 acres Removal, 20,000 feet Streambank Removal), Opportunity Ponds Disposal Option	4	$17,637	$908	$7,408	$36,310
5B. Removal of Exposed Tailings and in-situ Reclamation of Other Impacted Soils (700 acres In-situ, 167 acres Removal, 20,000 feet Streambank Removal), Opportunity Ponds Disposal Option	4	$26,845	$1,015	$11,275	$50,717
5C. Removal of Exposed Tailings and In-situ Reclamation of Other Impacted Soils (700 acres In-situ,167 acres Removal, 20,000 feet Streambank Removal), DCCA Disposal Option	12	$29,413	$1,062	$12,353	$54,943
5D. Removal of Exposed Tailings and In-situ Reclamation of Other Impacted Soils (700 acres In-situ, 167 acres Removal), Opportunity Ponds Disposal Option with Streambank Stabilization and Riparian Corridor Buffer (298,848 feet)	4	$45,572	$1,581	$19,140	$84,327
6A. Removal of Exposed Tailings and Other Impacted Soils (285 acres Removal, 70,000 feet Streambank), Opportunity Ponds Disposal Option	4	$25,232	$999	$10,597	$48,225
6B. Removal of Exposed Tailings and Other Impacted Soils (867 acres Removal, 95,000 feet Streambank), Opportunity Ponds Disposal Option	4	$45,903	$1,251	$19,279	$80,712
6C. Removal of Exposed Tailings and Other Impacted Soils, Opportunity Ponds Disposal option with Streambank Stabilization and Riparian Corridor Buffer (298,848 Streambank feet)	4	$62,322	$1,771	$26,175	$110,478

EXHIBIT 2-18
Reach A Alternative Cost Estimate Summary

Alternative	Sub-Excavation Depth (inches)	Capital Cost (000s)	Annual Monitoring and Maintenance Cost (000s)	Miscellaneous Costs (000s)	Net Present Value (000s)
7A. Total Removal Unless Overlain by Woody Vegetation (2,600 acres Removal, 150,000 feet Streambank Reconstruction), Opportunity Ponds Disposal Option	4	$97,782	$1,834	$41,068	$161,614
7B. Total Removal Unless Overlain by Woody Vegetation (2,600 acres Removal), Opportunity Ponds Disposal Option with Streambank Stabilization and Riparian Corridor Buffer (298,848 feet Streambank)	4	$106,811	$2,233	$44,861	$179,381
8A. Total Removal (3,500 acres Removed and 350,000 feet Streambank Reconstruction), Opportunity Ponds Disposal Option	12	$222,011	$3,233	$93,245	$355,370
8B. Total Removal, Opportunity Ponds Disposal Option, with Streambank Stabilization and Riparian Corridor Buffer (298,848 feet Streambank)	12	$227,713	$3,633	$95,640	$368,438

Note: This exhibit was prepared in March 2002 for the *Feasibility Study*. These costs may be somewhat out of date, but reflect the source of the bulk of the costs for each alternative, such as operations and maintenance and capital costs. The current cost range for the selected remedy is presented in Section 13.13, page 138. Cost had to be revised because the selected remedy is a combination of various alternatives.

9.2 Expected Outcomes of Each Alternative

None of the alternatives, if implemented individually, would completely achieve all the EPA-identified RAOs, particularly meeting WQB-7 surface water quality for copper, because of continued loading from tributary, upstream, and residual contamination sources left onsite. Upon completion of construction, Alternatives 2 through 8 would reduce or eliminate the potential for dissolved metals pulse events by reclaiming or removing exposed tailings areas. However, Alternative 2 would not address terrestrial risks in impacted areas or chronic aquatic and erosional risks along streambanks, and therefore would not be protective or ARAR compliant. Alternatives 3 through 8 would fully address these risks to varying degrees in ways more fully described below. Groundwater RAOs would be achieved more quickly under Alternatives 7 and 8, as compared to other alternatives. Alternatives 4 through 6 may achieve these groundwater RAOs over a longer period of time, and Alternatives 2 and 3 would take the longest period of time for compliance and may not achieve compliance at all. Alternatives 2 through 8 could all be utilized to add on to human health protection components.

9.2.1 Alternative 1—No Further Action

Because no further action would be taken under this alternative, the expected outcome would be that slickens (which are presently almost 100 years old) and the high streambank erosion rates that landowners experience today would likely continue for the foreseeable future. Impacted areas may improve over time, but many risks and impacts would remain for many years. Certain human health risks and ecological impacts would be likely. ARARs and replacement standards would not be achieved, terrestrial risks at exposed tailing areas would not be addressed, and erosion and stream instability would continue.

9.2.2 Alternative 2—In-Place Reclamation of Exposed Tailings

Because this alternative provides only in-situ reclamation of exposed tailings areas, the expected outcome would be to possibly address the lack of vegetation on slickens and to stop pulse event contributions to the river. However, there would be substantial uncertainty as to the success of vegetation in these areas and long term potential intrusive operation and maintenance relating to the treated areas. The objective for in-situ reclamation of exposed tailings could be met within a few years, but the remaining buried tailings, impacted soils, and contaminated streambanks would continue to cause vegetation and aquatic impacts and land use would be inhibited. Continued ecological impacts would be likely. ARARs and replacement standards would not be achieved, and erosion and stream instability would continue.

9.2.3 Alternative 3—In-Place Reclamation of Exposed Tailings and Other Impacted Soils and Vegetation Areas

Alternative 3 calls for in-situ reclamation of exposed tailings and in-situ reclamation of buried tailings areas with impacted vegetation, but has no streambank stabilization component. Areas of buried tailings without impacted vegetation would not be actively remediated. These areas may be slated for no further action, or they may be addressed with a BMPs/land use management approach. The slickens areas would be subject to the same uncertainty and intrusive operation and maintenance as described above for Alternative 2.

This alternative would take a long period of time for ARARs compliance and may not achieve compliance at all. It would not address erosion and stream stability. Continued ecological impacts would be likely.

9.2.4 Alternative 4—In-Place Reclamation of Exposed Tailings and Other Impacted Soils and Vegetation Areas with Streambank Stabilization

Alternative 4, like Alternative 3, calls for in-situ reclamation of exposed tailings and in-situ reclamation of buried tailings areas with impacted vegetation. Under Alternative 4, areas of buried tailings without impacted vegetation would not be actively remediated, but would be addressed with BMPs and a land use management approach. Adding the streambank stabilization component would address the risk and erosional problems at the Clark Fork River OU and inhibit the migration of waste left in place into the river. The treated slickens areas would be subject to the same uncertainty and intrusive operation and maintenance activities as described above in Alternative 2. ARARs and replacement standard compliance would be achieved more quickly than Alternative 3, although there would be some uncertainty regarding groundwater ARAR compliance. There would be less construction impact to the valley as compared to the alternatives below.

9.2.5 Alternative 5—Removal of Exposed Tailings and In-Place Reclamation of Other Impacted Soils and Vegetation with Streambank Stabilization

Alternative 5 calls for the removal of exposed tailings in Reach A. Other impacted soils and vegetation areas would be reclaimed in place. Alternatives 5A, 5B, and 5C would only remove exposed tailings. Areas of buried tailings would be addressed in the same manner as described for Alternative 4. Under Alternatives 5A, 5B, and 5C, when removal of exposed tailings intercepts streambanks, those streambanks would be reconstructed. Areas not addressed by the removal or the in-situ reclamation, including streambanks, may be addressed by BMPs and a land use management approach. This approach takes aggressive action to address the slickens, a principal threat waste, and avoids the potential uncertainties and intrusive operation and maintenance activities for these areas. The in-situ treatment of the impacted areas addresses the remaining waste impacted areas in a manner that is likely to be successful, but will require monitoring and operation and maintenance and careful land use. The streambank component addresses the risk and erosional problems at the Clark Fork River OU, and inhibits the migration of waste left in place into the river. The approach also limits the amount of replacement soils needed, consequently preserving more of the intact floodplain. Construction impacts would be somewhat more intrusive than those for the previous alternatives, but they would be manageable and similar to impacts for similar cleanup projects in the Clark Fork Basin. Many of the normal land uses could be continued following construction, with some ICs and land management planning. ARARs and replacement standard compliance would be achieved in a reasonable time, with some lesser uncertainty remaining regarding groundwater ARAR compliance.

9.2.6 Alternative 6—Removal of Exposed Tailings and Other Impacted Soils and Vegetation with Streambank Stabilization

Alternative 6 calls for removal of exposed tailings and removal of areas of buried tailings with impacted vegetation. Because no in-situ reclamation is proposed, the remaining impacted soils would be subject to the natural healing that would take place during the next century. The streambank stabilization component would be the same as described in Alternatives 4 and 5. All uncertainties associated with the use of in-situ treatment would be eliminated under this alternative. Construction impacts would be significantly higher, and costs would be substantially elevated. EPA is not confident that construction impacts from the additional removal activities could be managed successfully. There would be less land use planning required under this alternative. The streambank component would address the risk and erosional problems at the Clark Fork River OU. ARAR and replacement standard compliance would be likely, with less groundwater ARAR compliance uncertainty.

9.2.7 Alternative 7—Total Removal Unless Overlain by Woody Vegetation

Because Alternative 7 is intended to allow for as much removal as possible, while leaving existing woody vegetation in place, risks would be addressed without uncertainty. It could take a dozen or more years before construction is complete and exposed tailings have been removed. Construction impacts would be substantial during this time frame and very difficult to manage. Replacement soils could be difficult to find in sufficient quantities. Costs would be substantially elevated. The streambank component would address the risk and erosional issues at the Clark Fork River OU. Because any buried tailings and metals-impacted soil areas underlying woody vegetation would remain, minor long-term ecological impacts may continue. As noted, ARAR and replacement standard compliance would be achieved in a shorter amount of time and with even greater certainty. The removal process would create significant short-term impacts.

9.2.8 Alternative 8—Total Removal

Because Alternative 8 is the total removal alternative, it could take 24 years or more before construction is complete and all exposed and buried tailings areas have been removed. It would have the same positive risk reduction and ARAR compliance effects as described in Alternative 7. The removal process would create significant short-term and potentially long-term impacts because the entire floodplain of the Clark Fork River would essentially be totally reconstructed. Many of these risks may not be manageable. Costs would increase substantially over prior alternatives.

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10 Comparative Analysis of Alternatives

10.1 EPA's Nine Evaluation Criteria

The NCP at 40 CFR § 300.430(e)(9)(iii) and (f)(1)(i) requires EPA to utilize and evaluate the nine criteria listed at Section (e)(9)(iii) to select a remedial action for a site. Section 300.430(f)(5) requires EPA to document how the evaluation of the nine criteria were used to select a remedy. The major objective of this activity is to evaluate the relative performance of each alternative with respect to each criteria, and consider the tradeoffs of each, selecting one, or the combination of several, as a comprehensive remedy. This helps ensure that advantages and disadvantages of each alternative are clearly understood. The nine evaluation criteria are as follows:

- **Threshold Criteria**—*Must be Addressed*
  1. Overall Protection of Human Health and the Environment
  2. Compliance with ARARs
- **Balancing Criteria**—*Must be Considered*
  3. Long-Term Effectiveness and Permanence
  4. Reduction of Toxicity, Mobility, and Volume
  5. Short-Term Effectiveness
  6. Implementability
  7. Capital and Operating and Maintenance Cost
- **Modifying Criteria**—*Must be Considered*
  8. State Acceptance
  9. Community Acceptance

A brief description of each criterion follows in the remainder of this section (10.1). Section 10.2, *Comparison of Alternatives for Each Evaluation Criteria*, contains a text description of how the alternatives compared within each evaluation criterion, including State and community acceptance. This represents EPA's final evaluation of the criteria following receipt of public comments. Next, Exhibit 2-19, *Comparative Analysis of Alternatives for the Clark Fork River Feasibility Study*, summarizes the evaluation of the first seven criteria that was presented in the *Feasibility Study* (Atlantic Richfield Company 2002). Because this ranking was completed long before the issuance of the *Proposed Plan* and the public comment period, the modifying criteria of State and community acceptance were not included in this analysis. Since the public comment period, these two factors were analyzed in the *Responsiveness Summary* (Part 3 of this *Record of Decision)* and in the consideration by EPA of the public comments and in further discussions with the State.

10.1.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through removal, treatment, engineering controls, or ICs. The extent to which each alternative met the following was evaluated:

- Returns the soils and terrestrial vegetation to an acceptable performance level.
- Protects human health exposures to arsenic for current and reasonably anticipated land uses.
- Eliminates or significantly reduces contaminated runoff pulses, which are acute risks to aquatic receptors.
- Reduces chronic risks to aquatic receptors; these risks are primarily associated with copper loading and sedimentation during typical and high flows.
- Contributes to floodplain stability by reducing streambank erosion.
- Contributes to retaining the inherent geomorphic features of a cobble-bed, single-thread, meandering river.
- Conducts cleanup in a timely manner (7 to 10 years versus 20 or more years); achievement of floodplain integrity in as short a time as possible, which is important.

10.1.2 Compliance with ARARs

Section 121(d) of CERCLA and NCP 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless ARARs are waived under CERCLA Section 121(d)(4). A complete list of ARARs and invoked waivers is included as Appendix A to this *Record of Decision*. That appendix contains appropriate definitions and descriptions of terms relevant to the ARAR identification and compliance analysis for this site. The ability of each alternative to meet the following key ARARs is highlighted in the analysis.

- **Contaminant Specific ARARs**—Includes Montana surface water standards and the ability of each alternative to achieve these water quality standards, and compliance with water quality standards under events such as thunderstorm pulse events, high flows, and ice scour events. The Montana groundwater standards are also important.
- **Location Specific ARARs**—Includes Montana's Solid Waste and Floodplain Management Standards and ARARs for protected resources. Care was given to looking at ARARs specific to the Grant-Kohrs Ranch National Historic Site.
- **Action Specific ARARs**—Mine reclamation standards that specify requirements for re-establishing remediated areas were examined, along with solid waste and floodplain requirements.
- **Waived ARARs**—A waiver of the State's surface water standards for copper is appropriate for this site. The replacement standard is the Federal ambient water quality criterion for copper. A waiver of certain State solid waste and floodplain management standards for areas designated for in-situ treatment is also appropriate.

10.1.3 Long-Term Effectiveness and Permanence

Long term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels are achieved. This criteria is an important one to the State, other Trustees, and the public, and is emphasized in the NCP and its preamble. Key issues examined under this criteria include the following:

- **Magnitude of Residual Risk**—Considered the future effects on surface water and aquatic systems, groundwater, vegetation, and terrestrial ecosystems, and contribution to enhancing the geomorphic integrity of the floodplain.
- **Adequacy and Reliability of Controls**—Considered the use and adequacy of institutional controls and BMPs.

10.1.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the technologies that may be included in a given remedy. As applied to this site, reduction in mobility and volume of contamination within the floodplain is an important balancing consideration. The effectiveness of the in-situ treatment technology and its resultant reduction in toxicity of site contaminants was also important.

10.1.5 Short-Term Effectiveness

Short term effectiveness addresses the period of time need to implement a remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved. Detailed issues specific to this site and important to landowners and others that were especially considered for each alternative are as follows:

- **Protection of Community and Workers During Remedial Actions**—Considered the volume of materials proposed to be dealt with and the time and safety elements. Alternatives that involved more in-situ treatment rather than total removal could generally be implemented in a shorter period of time with less truck activity and traffic on local roads, and were therefore considered more protective in the short term.
- **Environmental Impacts of Implementation**—Addressed impacts on wetlands and terrestrial ecosystems, turbidity and other impacts to water quality resulting from proposed activities, and short-term impacts on the stability of geomorphic features and the floodplain.
- **Time Until Remedial Action Objectives are Achieved**—Considered how long the remedial action would take, once implemented, to achieve RAOs.

10.1.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Generally, factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are considered. Key issues for this site highlighted in the analysis of this criterion are as follows:

- **Technical Feasibility**—The ability to construct and operate the technology, time required for implementation, reliability of the technology, ability to monitor effectiveness, and ease of undertaking additional actions should they be necessary at some future date.
- **Administrative Feasibility**—The ability to obtain approvals and coordinate with other agencies. This included working with landowners, counties, municipalities, and Federal regulatory and non-regulatory authorities.
- **Availability of Services and Facilities**—Considered the availability of necessary equipment, specialists, materials (including backfill materials), and the availability of offsite facilities for disposal of wastes, if necessary.
- **Backfill Availability and Landowner Access**—These factors are especially important considerations at this site, where concerns increase as removed waste volumes increase.

10.1.7 Capital and Operating and Maintenance Cost

This criteria involved the comparison of net present worth costs for each alternative as proposed. Cost effectiveness was then considered, as described in NCP section 300.430(f)(ii)(D).

10.1.8 State Acceptance

Evaluation of State acceptance is required and, because this is a modifying criteria, EPA has worked closely with the State of Montana to develop a remedy that is acceptable to the State. The State would not accept Alternatives 1 through 4, because of its concern for long term permanence and effectiveness and compliance with ARARs. The State's view is that in-situ treatment is not appropriate for the exposed tailing areas. The State has a general preference for removal of contamination from a floodplain. The State has concurred in this Selected Remedy in the State's concurrence letter, provided in Appendix F.

EPA also worked closely with the NPS regarding the Selected Remedy and its application to the Grant-Kohrs Ranch National Historic Site. DOI concurs in this remedy.

10.1.9 Community Acceptance

Similar to State acceptance, community acceptance is not necessarily required, but is critical to actual implementation of the Selected Remedy. There was a large amount of public comment on the *Proposed Plan* for this site. Most commenters generally supported EPA's plan. Most of the impacted areas (approximately 89 percent) within the Clark Fork River OU are located on private lands, and landowner acceptance is important for gaining access, implementing ICs, and ensuring a successful project. EPA carefully considered landowner and Powell County concerns relating to land use impacts and safety, and modified the Selected Remedy from the *Proposed Plan* to address some of these issues while still meeting other CERCLA remedy selection requirements. There were several hundred public commenters on the *Proposed Plan*, and EPA carefully considered this input as well. Some public commenters wanted EPA to carefully review streambank components to ensure the long term reliability of this component. Many public commenters and the DOI urged EPA to give special consideration to ARARs associated with the Grant-Kohrs Ranch National

Historic Site. These comments are reflected in the Selected Remedy, which was modified from the *Proposed Plan* to address these concerns.

10.2 Comparison of Alternatives for Each Evaluation Criteria

EPA worked to identify the best combination of Alternatives 4, 5, and 6 in order to match its technical evaluation of in-situ treatment with the overall aspects of removal. Additional detail about how the alternatives compared based on the nine evaluation criteria is provided in the remainder of this section. This analysis expands on and modifies the *Feasibility Study* analysis.

10.2.1 Overall Protection of Human Health and the Environment

As previously noted, each alternative except Alternative 1 can include the important human health protection components, so these pathways are not differently addressed under the active alternatives. Alternative 1, the No Action Alternative, does not address the unacceptable risks and pathways and therefore was not considered further. Alternatives 2 and 3 do not reliably address the environmental risk pathways for slickens and leave large amounts of contaminants subject to residual risk within the ecosystem. The lack of a streambank component leaves a major risk and pathway unaddressed under these alternatives, which is not acceptable.

Alternatives 4, 5, and 6 each can meet the threshold criteria of overall protectiveness. However, each of these alternatives have benefits and drawbacks as demonstrated in the *Feasibility Study*. The sub-alternative for streambank and riparian corridor protection developed by EPA and made a part of each of these alternatives was judged to be crucial for addressing overall protection of the environment. It addresses sediment copper loading, erosion risks, and related exposure pathways. Other streambank protection sub-alternatives do not fully address these pathways and are not reliable over time, leaving Alternatives 4B4, 5D, and 6C as the only acceptable versions of these alternatives. Alternatives 7 and 8 would also meet the protectiveness threshold criteria, although both would take a long time to implement, which could present the risk of floodplain instability if major flooding occurred during construction.

10.2.2 Compliance with ARARs

ARARs compliance presents difficult issues for the Clark Fork River OU. According to modeling projections for copper and sediment, none of the alternatives were expected to fully comply with all water quality standards in surface water, and a waiver of the copper standard is justified for this site. There is also some uncertainty as to whether any of the alternatives could meet groundwater standards within the shallow aquifer for arsenic within a reasonable time frame. Alternatives 2 and 3 present great uncertainty, Alternatives 4 through 5 present some uncertainty, and Alternatives 6 through 8 present less uncertainty for the ability to meet these groundwater ARARs. Waivers for important State solid waste and floodplain protection ARARs were considered possible for Alternatives 5 through 8, for in-situ treatment of impacted areas. The State did not agree that a waiver was appropriate for Alternative 4.

When compared to Alternative 4B4, Alternatives 5D and 6C are more likely to lead to groundwater improvement and possible compliance with groundwater ARARs. Although in-situ treatment may mobilize arsenic into groundwater, EPA believes that removal of slickens areas, increased vegetative cover, and decreased percolation rates will lead to groundwater compliance within a reasonable period of time. These alternatives are also projected to move closer to State water quality standards than Alternative 4B4, and would reduce the amount of fine-grained contaminated sediment in the river bed.

Overall, Alternatives 5D through 8 could comply with ARARs or justify a waiver. Alternatives 6C, 7, and 8 achieve ARAR compliance more fully than Alternative 5. These alternatives, however, have some other criteria shortcomings.

10.2.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence criteria considers the expected residual risk and the ability to maintain reliable protection of human health and the environment after implementation of the remedy. Alternatives 1 and 2 leave large volumes of impacted soils without some form of remediation, resulting in residual risk within the ecosystem, and are not considered reliable or permanent. Alternative 4B4 relies on in-situ treatment of a principal waste—slickens—and there was uncertainty as to the long term reliability of this technology when applied to slickens wastes that have low pH, low organic content, and relatively higher levels of contamination. Alternatives 7 and 8 propose an aggressive removal of large volumes of materials from the floodplain with less uncertainty about success, but increase risks relating to flooding during implementation. Alternative 5C effectively and permanently addresses exposed tailings and streambank contamination, and relies on in-situ treatment for impacted areas. EPA believes that in-situ treatment is reliable in these areas because of the existing organic material present there, and the more favorable pH and contaminant conditions. EPA recognizes some uncertainty with regard to the long term permanence in these areas, but believes that careful implementation of the in-situ treatment technology in these areas will result in long term effectiveness and permanence. Alternative 6C, removal of exposed tailings and impacted soils and vegetation, eliminates all in-situ treatment uncertainty and better addresses long-term effectiveness and permanence than Alternative 5, and Alternative 5 addresses this criterion better than Alternative 4.

10.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternatives 7 and 8 address reduction in mobility and volume to a greater degree than other alternatives because they remove more contamination from the floodplain, where it is likely to become mobile over time.

Alternative 4B4 reduces toxicity through in-situ treatment of large areas. It does not reduce mobility or volume. Alternatives 5D and 6C provide some reduction in mobility and volume by removal of contaminants from the floodplain. Alternative 5D addresses the principal waste—slickens and phytotoxic streambanks—in a more reliable manner by removing these wastes from the floodplain and thereby decreasing mobility and volume of metals. Excavation of slickens will remove approximately 750 tons of arsenic and 1,900 tons of copper from the floodplain. It also decreases toxicity by using in-situ treatment in impacted areas. Alternative 6C, removal of exposed tailings and impacted soils and vegetation, better addresses reduction of toxicity and mobility than Alternatives 4 and 5 because it reduces mobility for a large volume of contamination. Alternative 5 also relies on in-situ treatment, but in areas where organic content is present and some vegetation has established over time. EPA considers in-situ treatment in these areas to be reliable in the long term, as long as it is designed, carefully implemented, and monitored over time and therefore effective in reducing toxicity. Alternatives 2 and 3 do not reduce mobility or volume of metals at all. Both reduce toxicity to some extent, although Alternative 2 does so in a limited area.

10.2.5 Short-Term Effectiveness

Because of the large volumes of material that would be removed in Alternatives 7 and 8, these alternatives pose a potential for greater short-term risk based on potential for traffic and equipment related accidents, risks to the stability of the floodplain, and the duration of the remedial activity before full implementation occurs. Alternative 6 exhibits concerns in this area as well, but to a lesser degree. These alternatives would take a relatively longer period of time to implement, but would achieve performance standards more quickly. Alternatives 3 through 5 tend to rely more exclusively on in-situ treatment or a combination of in-situ and removal of specifically targeted areas including riparian areas and streambanks. These alternatives create less traffic and construction risks as a result. These alternatives would take a relatively moderate amount of time to implement (EPA estimates 10 years). They would achieve performance standards in a greater amount of time than Alternatives 6, 7, and 8. Variations of Alternatives 4 and 5 tend to rank high by limiting the volume of materials for removal, reducing the impacts of treatment on the floodplain, and promoting a relatively short healing process for recovery. Alternatives 2 and 3 rank highest for implementability, because of minimal truck traffic and a minimal period of implementation. These alternatives exhibit low short term effectiveness problems since the performance standards are not achieved in the short term if at all.

10.2.6 Implementability

Because of the large volumes of material that would be removed in Alternatives 7 and 8, these alternatives are difficult to implement in a timely fashion, would require considerable effort to coordinate approvals with multiple landowners and agencies, and may tax the local resources to implement removals, transport to repositories, and backfill excavations. Alternative 6C, removal of exposed tailings and impacted soils and vegetation, also has some of the same shortcomings regarding implementability because of the increased need for backfill and potential difficulties with landowner access. Alternatives 3, 4, and 5, which apply in-situ treatment and could be readily implemented on smaller areas in shorter periods of time, ranked higher under this criteria. Specifically, Alternatives 4B4 and 3B lead the ranking under this criteria because of the exclusive use of in-situ treatment. Alternative 5D will require backfill, but EPA believes that careful design, which may look for opportunities to create wetlands and minimize backfill needs, will make this a manageable problem. EPA also believes that modifications to the *Proposed Plan* regarding careful attention to landowner needs, in combination with CERCLA's access provisions, will meet implementability concerns regarding land owner access and cooperation.

10.2.7 Cost

Alternatives 1 and 2 are least costly, but do not achieve basic threshold criteria. Because of the large volumes of material that would be removed in Alternatives 7 and 8, they are much more costly than the other alternatives. Alternative 8 is the most costly; Alternative 7 would be approximately one-half the cost of Alternative 8. Depending on the amount of material treated or removed in the sub-alternatives, Alternatives 3 through 6 range from 25 to 75 percent of the total cost of Alternative 7. Using the criteria found in NCP section 400.300(f)(ii)(D), EPA believes that Alternatives 7 and 8 would not be cost effective, and that the overall effectiveness of Alternative 5 best meets the cost effectiveness criteria.

10.2.8 State Acceptance

The State's consistent interpretation that removal is more protective and more fully complies with Montana ARARs than in-situ treatment influenced the final decision. DEQ believes removal of contamination offers a more permanent and effective remedy where contamination can feasibly and reliably be removed. DEQ's concerns on the Clark Fork OU focus on surface and groundwater protection as well as ARAR compliance. DEQ considered public comment received on both the *Proposed Plan* and *Feasibility Study* prior to making its determination as to State concurrence. EPA has worked closely with the State in developing the Selected Remedy. The State's Concurrence Letter is provided in Appendix F.

10.2.9 Community Acceptance

In response to the *Proposed Plan,* EPA received numerous comments expressing a variety of opinions. EPA values public input and has incorporated public input where possible and consistent with statutory and regulatory mandates and EPA guidance. The *Record of Decision* has been modified in response to comments on the *Proposed Plan*. The changes are explained in Section 15, page 2-159. Many of these changes were addressed towards landowners' concerns.

Of the public comments received on the *Proposed* Plan, most of the people who specifically stated an opinion about the plan (fully support, conditionally support, or oppose), support the Selected Remedy. In fact, 88 percent of those who stated an opinion fully supported the Selected Remedy as described in the *Proposed Plan.* A segment of the community expressed concern about the long term effectiveness of in-situ treatment. Another segment of the community expressed concern about adequate protection and ARARs compliance for the Grant-Kohrs Ranch National Historic Site. Some commenters emphasized the need for secure streambank stabilization. A segment of the community does not support alternatives that will take a long period of time to implement, cause safety concerns, or intrude on landowner uses. Powell County representatives strongly support this view. Certain landowners at this site have expressed these concerns to EPA. On the other hand, Anaconda-Deer Lodge County representatives and certain landowners expressed a preference for more removal of the contamination.

In summary, EPA has received strong support for a clean-up of the Clark Fork throughout the Deer Lodge Valley. The *Proposed Plan* integrated elements of Alternatives 4, 5, and 6. EPA supports the use of a variety of remedial tools to assist with the clean-up effort, including careful monitoring and implementation of in-situ treatment, serious consultation with individual landowners in planning activities on their property, and weed control. EPA worked closely with NPS to modify the *Record of Decision* to address NPS ARAR concerns. EPA recognizes the potential hardship to landowners and plans to coordinate the remedy with landowners. EPA also intends to continue to work closely with the community and landowners to formulate a successful clean-up.

10.2.10 Conclusion of Alternative/Criteria Evaluation

EPA combined elements of Alternatives 4B4, 5D, and 6C as the Selected Remedy. The Selected Remedy most closely resembles Alternative 5D. The Selected Remedy reflects a fair balance between the long-term and short-term effectiveness and permanence, reduction of mobility, toxicity, and volume, and implementability issues associated with these alternatives. Long term effectiveness and permanence weighed heavily in EPA's decision to require the removal of most slickens, where uncertainty is greatest regarding the effectiveness of in-situ treatment. Reduction in mobility and toxicity associated with removal and in-situ treatment also influenced the choice of the Selected Remedy. EPA carefully examined the short term effectiveness and implementability criteria, and believes these issues can be managed under EPA's Selected Remedy. ARAR compliance with appropriate waivers will be achieved under the Selected Remedy with moderate uncertainty. Removal of slickens, in most cases, with in-situ treatment of impacted soils and vegetation areas in most cases, as defined in Section 12, page 2-77, ensures overall protectiveness and long-term effectiveness. Use of in-situ treatment for significant portions of the impacted soils and vegetation areas will lessen short-term safety and environmental impacts, and allow for a faster remedial action construction period. EPA believes the Selected Remedy is cost effective and will achieve benefits and effectiveness proportional to the expected costs. EPA and DEQ aim to address public concerns regarding the length of time and the intrusiveness of remediation by focusing on sequencing actions to allow for cleanup at various areas and a combination of techniques in a given area, and by working closely with landowners during implementation. Finally, State acceptance was important to EPA so removal of some contamination, as a more permanent and effective remedy, is reflected in the *Selected Remedy*.

EXHIBIT 2-19
Comparative Analysis of Alternatives Summary versus Performance Criteria for the Clark Fork River *Feasibility Study*

		Performance Evaluation of Remedial Alternatives Against Detailed Analysis Criteria							
		Threshold Criteria		Balancing Criteria					
	Alternatives	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume Through Treatment	Short-Term Effectiveness	Implementability	Capital Operating and Maintenance Cost	Total
1.	No Further Action	NR	NR	NR	NR	NR	NR	NR	NR
2.	In-situ Reclamation of Exposed Tailings (167 acres)	1.0	2.0	2.8	2.0	3.2	4.0	5.0	20.0
3A.	In-situ Reclamation of Exposed Tailings and Other Impacted Soils (285 acres)	1.0	2.0	2.8	2.0	3.2	3.9	5.0	19.9
3B.	In-situ Reclamation of Exposed Tailings and Other Impacted Soils (867 acres)	1.5	2.1	3.0	3.0	3.6	3.7	4.0	20.9
4A1.	In-situ Reclamation of Exposed Tailings and Other Impacted Soils (285 acres) with Streambank Stabilization (22,367 feet), Criteria 1	1.5	2.1	3.2	2.0	3.6	3.6	5.0	21.0
4A2.	In-situ Reclamation of Exposed Tailings and Other Impacted Soils (285 acres) with Streambank Stabilization (72,777 feet), Criteria 2	2.0	2.3	3.2	2.0	3.2	3.6	4.0	20.3
4A3.	In-situ Reclamation of Exposed Tailings and Other Impacted Soils (285 acres) with Streambank Stabilization (160,450 feet), Criteria 3	2.5	2.4	3.2	2.0	2.8	3.6	4.0	20.5
4A4.	In-situ Reclamation of Exposed Tailings and Other Impacted Soils (272 acres) with Streambank Riparian Buffer Zone (158 acres removal, 264,000 feet remediated streambank), Criteria 4, Opportunity Ponds Disposal	3.0	2.5	3.2	2.0	3.6	3.6	3.0	20.9
4B1.	In-situ Reclamation of Exposed Tailings and Other Impacted Soils (867 acres) with Streambank Stabilization (22,367 feet), Criteria 1	2.5	2.7	3.6	3.0	3.4	3.6	4.0	22.8
4B2.	In-situ Reclamation of Exposed Tailings and Other Impacted Soils (867 acres) with Streambank Stabilization (72,777 feet), Criteria 2	2.5	3.0	3.6	3.0	3.2	3.3	4.0	22.6
4B3.	In-situ Reclamation of Exposed Tailings and Other Impacted Soils (867 acres) with Streambank Stabilization (160,450 feet), Criteria 3	2.5	3.1	3.4	3.0	3.0	3.1	4.0	22.1
4B4.	In-situ Reclamation of Exposed Tailings and Other Impacted Soils (867 acres) with Streambank Riparian Buffer Zone (158 acres removal, 264,000 feet remediated streambank), Criteria 4, Opportunity Ponds Disposal	4.0	3.6	4.0	3.0	3.4	3.7	3.0	24.7
5A.	Removal of Exposed Tailings and In-situ Reclamation of Other Impacted Soils (118 acre in-situ, 167 acres removal, 18,370 feet streambank reconstruction), Opportunity Ponds Disposal	1.0	2.8	3.2	3.0	3.8	3.6	4.0	21.4
5B.	Removal of Exposed Tailings and In-situ Reclamation of Other Impacted Soils (700 acres in-situ, 167 acres removal, 20,000 feet streambank reconstruction), Opportunity Ponds Disposal	2.5	2.4	3.0	3.0	3.2	3.1	3.0	20.2
5C.	Removal of Exposed Tailings and In-situ Reclamation of Other Impacted Soils (700 acres in-situ, 167 acres removal, 18,370 feet streambank reconstruction), DCCA Disposal (12 inches)	2.5	2.4	3.0	3.0	3.4	2.8	3.0	20.1

EXHIBIT 2-19
Comparative Analysis of Alternatives Summary versus Performance Criteria for the Clark Fork River *Feasibility Study*

		Performance Evaluation of Remedial Alternatives Against Detailed Analysis Criteria							
		Threshold Criteria		Balancing Criteria					
	Alternatives	**Overall Protection of Human Health and the Environment**	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, and Volume Through Treatment**	**Short-Term Effectiveness**	**Implementability**	**Capital Operating and Maintenance Cost**	**Total**
5D.	Removal of Exposed Tailings and In-situ Reclamation of Other Impacted Soils (660 acres in-situ, 167 acres removal, 14,164 feet streambank reconstruction), Opportunity Ponds Disposal with Streambank Riparian Buffer Zone (158 acres removal, 264,000 feet remediated streambank), Opportunity Ponds Disposal	3.5	3.6	4.0	4.0	3.4	3.4	3.0	24.9
6A.	Removal of Exposed Tailings and Other Impacted Soils (285 acres removal, 43,845 feet streambank reconstruction), Opportunity Ponds Disposal	2.5	2.9	3.4	3.0	3.0	3.1	4.0	21.9
6B.	Removal of Exposed Tailings and Other Impacted Soils (867 acres, 95,000 feet streambank reconstruction), Opportunity Ponds Disposal	2.5	3.3	3.6	4.0	2.4	3.1	3.0	21.9
6C.	Removal of Exposed Tailings and Other Impacted Soils (827 acres removal, 82,500 feet streambank reconstruction) with Streambank Riparian Buffer Zone (158 acres removal, 264,000 feet remediated streambank), Opportunity Ponds Disposal	3.0	3.6	4.0	4.0	2.8	3.3	2.0	22.7
7A.	Total Removal Unless Overlain by Woody Vegetation (2,432 acres removal, 131,583 feet streambank reconstruction), Opportunity Ponds Disposal	2.5	3.1	3.6	4.5	1.8	2.1	2.0	19.6
7B.	Total Removal Unless Overlain by Woody Vegetation (2,316 acres removal, 13,168 feet streambank reconstruction), 158 acres removal, 264,000 feet remediated streambank) Opportunity Ponds Disposal	2.5	3.4	4.0	4.5	2.0	2.3	2.0	20.7
8A.	Total Removal (3,570 acres removed, 345,163 feet streambank reconstruction), Opportunity Ponds Disposal	2.0	3.6	3.6	4.5	1.0	2.1	1.0	17.8
8B.	Total Removal (3,412 acres removal, 189,000 feet streambank reconstruction) with Streambank Riparian Buffer Zone (158 acres removal, 264,000 feet streambank reconstruction), Opportunity Ponds Disposal	2.0	3.4	4.0	4.5	1.0	2.1	—	18.0

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11 Principal Threat Wastes

11.1 Principal Threat Determination

Principal threat wastes are source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or present a significant risk to human health or the environment should exposure occur. The NCP establishes an expectation that EPA will use treatment to address principal threats posed by a site wherever practicable (NCP § 300.430(a)(1)(iii)(A)), but recognizes that treatment is not always possible. A source material is one that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air, or acts as a source for direct exposure.

Arsenic in tailings, mixed tailings, and soils has been determined to be the principal threat to human health within the Clark Fork River OU. If people were to live in areas where they have repeated, daily contact with tailings, risks from arsenic could be in the range of concern for both non-cancer and cancer (*Human Health Risk Assessment*, EPA 1998).

The slickens, which are low pH, exposed tailings that can form highly contaminated and mobile metal salts, present the major principal threat waste at the Clark Fork River OU. These wastes are present in the floodplain and are commonly toxic to terrestrial plants. Acidic runoff from exposed tailings, and particularly the green-blue copper salts that appear on slickens under dry climatic conditions, has the potential to contribute high concentrations of dissolved copper to the river. Copper is highly toxic to aquatic life and this source and pathway present an acute risk to aquatic life in the Clark Fork River OU. The other principal threat wastes at the Clark Fork River OU are contaminated streambanks within Reach A that are not well vegetated (Class 1 streambanks). During normal flows, these areas contribute large amounts of copper and other contaminants to the aquatic system and enable high erosional rates and geomorphic instability along the river.

These principal threat wastes lead to a lack of floodplain vegetation resulting from metal contamination and related acid generation. Other impacts include the following:

- Accelerated streambank erosion and stream channel migration, causing unacceptable chronic risks to aquatic life, as well as land management problems
- Vulnerability of floodplain to destabilization
- Potential and actual environmental hazards to terrestrial and aquatic life, especially from pulse and flood events
- Degraded groundwater quality
- Poor agricultural productivity
- Degraded surface water as a result of metals, arsenic, and sediments loading

Section 430(a)(1)(iii)(A) and EPA guidance states EPA's expectation that principal threat wastes will be addressed with reliable "treatment." For mobile waste in floodplains associated with acute risks, such as the exposed tailings and phytotoxic streambanks, removal and permanent disposal outside of the floodplain is required. EPA has thus focused its most aggressive remedial actions towards these principal waste areas. Other areas that are addressed in this remedy, such as the impacted areas that are not principal threat waste areas, present unacceptable risk conditions. EPA believes in-situ treatment and a BMP approach to these areas is an appropriate remedy for these non-principal threat wastes.

12 Definition and Description of Impacted Areas

The *Proposed Plan* (EPA 2002) summarized the types of riparian, floodplain, and upland areas that may be contaminated, the wastes that each media may contain, and how the remedy approach addresses each of these. The *Proposed Plan* was presented to the public and comments were received from many individuals, organizations, State and Federal trustees, and other groups. EPA has responded to all comments. These comments and responses are found in Part 3, *Responsiveness Summary*, of this *Record of Decision*. Responses to specific comments on the *Proposed Plan* received from Atlantic Richfield Company are also provided in Part 3, *Responsiveness Summary*. The contaminated areas are defined and described in this section, and general priorities for action are also given. The remedy is described in Section 13, page 2-81.

12.1 Definitions

Specific definitions for riparian and floodplain components as described in the *Proposed Plan* (EPA 2002) are provided below. These definitions are further refined in a detailed description of the Selected Remedy, which is the next section of this *Record of Decision* document.

- **Streambank—**The corridor from the active channel up to 50 feet out on either side. The streambank and riparian corridor buffer is delineated by measuring from the "bankfull" stage on each side of the river out a flexible or variable distance ***OR*** where the 100-year floodplain elevation is reached. In other words, areas outside the 100-year floodplain are not included in the streambank and riparian corridor buffer; and in cases where high banks are reached, the buffer will be less. Bankfull flow for the Clark Fork River at Deer Lodge has been calculated to be about 1,900 cubic feet per second (cfs; Griffin and Smith 2001). This equates to approximately a 7-year flood event. At this stage, the flow begins to spill out of the channel and disperse onto the floodplain.
- **Class 1 Streambanks—**Phytotoxic conditions exist as demonstrated by inability of the active channel areas to support and sustain significant amounts of woody and herbaceous vegetation. Streambanks are actively eroding and are significant contributors to contaminant release to the river. Remedial actions for this class include removal of phytotoxic materials and revegetation with deep, binding, woody vegetation. These actions may be implemented from a line at the lateral extent of inundation at bankfull stage out to approximately 50 feet from that line. Specific actions at a given Class 1 streambank will be determined in accordance with *Record of Decision* specifications and after consideration of site-specific design factors. Site-specific design factors include depth of removal (this is not necessarily the same as depth of contamination), depth to the water surface, depth to groundwater, current streambank stability, current vegetation status, infrastructure (bridges, culverts, etc.), surface drainage, future land use, BMPs, and others.

- **Class 2 Streambanks—**Generally non-phytotoxic conditions exist as demonstrated by some current woody and herbaceous vegetation, but streambanks are contaminated, not stable, and are eroding. Remedial actions for this class include supplemental revegetation and planting of deep, binding, woody vegetation. Reconfiguration of the streambanks may require minor removal or in-situ treatment. Design factors include current streambank stability, current vegetation status, infrastructure, surface drainage, future land use, BMPs, and others.
- **Class 3 Streambanks—**These streambanks are contaminated but they may have varying amounts of deep, binding, woody vegetation holding the streambank in place. Remedial actions possible for these areas include no action or minor actions to enhance woody vegetation within the buffer corridor and/or BMPs. Design factors include current vegetation status, current streambank stability, knowledge of underlying contamination, and current and future land use.
- **Slickens (exposed tailings)—** These sites generally lack vegetation (have less than 25 percent canopy cover) and present the principal waste in the Clark Fork River OU, along with Class 1 Streambanks. Estimated in the RI/FS at about 167 acres, but possibly up to 250 acres in Reach A with limited slickens in Reach B, these slickens areas are contaminated, causing largely bare ground. Scattered throughout Reach A, the areas number in the hundreds, are usually fractions of an acre in size, and are too toxic to support most vegetation or soil organisms. These areas are usually easy to recognize. Remedial action for most of these areas is removal, except as described in Section 13.3, page 2-85. Removal of slickens areas adjacent to the active channel would be done as part of streambank remedial actions.
- **Impacted Soils and Vegetation Areas—**Estimated in the RI/FS at about 700 acres, but possibly up to 1,760 acres in Reach A, these sparsely vegetated areas amount to everything between slickens and slightly impacted soils and vegetation areas that have an ecologically-sound plant community. Impacted soils and vegetation areas will generally be treated in-situ, except as described in Section 13.3, page 2-85.
- **Slightly Impacted Soils and Vegetation Areas—**These areas do not meet the characteristics or definitions of streambank and riparian corridor buffer, slickens (exposed tailings), or impacted soils and vegetation area. They are generally well vegetated and display no visible evidence of contaminated tailings, although the soil may contain copper concentrations above 300 ppm. Remedial actions for these areas are no action, or BMPs and ICs. They may be included in a land management plan along with adjacent areas being addressed by the remedy.

12.2 Priorities

The cleanup plan has three basic components:

1. Removal of tailings/slickens with soil replacement and revegetation
2. In-situ treatment of impacted soils and vegetation, followed by revegetation
3. Streambank stabilization

The basic cleanup approach is to perform in-situ treatment and tailings/slickens removal with soil replacement, followed by establishment of appropriate vegetation. A remedial design tool specifically developed for the Clark Fork River guides remedial design decisions for remedial action for a specific piece of land or polygon. This design tool is called CFR RipES. The system is described in Section 13.6.1, page 2-91. In addition, full details of the draft CFR RipES system are provided in the final CFR RipES document (EPA 2004).

In addition to the human health component of the remedy, there are five main areas for action and general priority and preference for the type of remedial action in each area. These actions are described below, in order of priority. These actions are further refined in a detailed description of the Selected Remedy, which is the next section of this *Record of Decision*.

1. **Class 1 streambanks**: Removal of contamination, reconstruction, and revegetation of streambanks where chemical conditions do not allow the effective establishment of woody and herbaceous vegetation. Further detail about this type of action is provided in Section 13, *Selected Remedy*.
2. **Exposed tailings or slickens areas**: Removal of exposed tailings with the exceptions as described in Section 13, *Selected Remedy*.
3. **Class 2 streambanks**: Revegetate streambanks where chemical conditions (demonstrated by some significant level of woody and herbaceous vegetation) allow effective establishment of vegetation. Reconfiguring banks (e.g., scalloping or selective removal) could be required where other treatments may not be effective. Further detail about this type of action is provided in Section 13, *Selected Remedy*.
4. **Impacted soils areas with impacted vegetation**: In-situ treatment or removal, to be decided by the criteria described in Section 13, *Selected Remedy*.
5. **Class 3 streambanks**: Continue or apply BMPs on all other streambanks with deeply bound woody vegetation and a root-mass that maintains streambank stability. BMPs are described in Section 13, *Selected Remedy*, in further detail.
6. **Slightly impacted soils and vegetation areas:** Although not actively addressed in a remedial action, these areas may be included, along with adjacent areas of the floodplain being addressed by a remedial action, in a property-specific land management plan.

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13 Selected Remedy

13.1 Rationale for the Selected Remedy

The upper reaches of the Clark Fork River (Warm Springs to Drummond) can be characterized as follows: this river has intermittent areas of exposed tailings, often barren of vegetation, or supporting stressed vegetation along its banks and across its floodplain. These conditions have created a series of interrelated environmental and human health problems, including sedimentation (both contaminated and uncontaminated), channel instability, excess soil erosion, reduced agricultural potential, and ecological hazard. The absent and stressed vegetation resulted from phytotoxic environments, which in turn were caused by low pH and elevated metals in tailings and contaminated soils deposited along the banks and floodplain of the river. Hazards to both aquatic and terrestrial receptors are well documented in EPA's *Ecological Risk Assessment* (1999). The risks to human populations are documented in EPA's *Human Health Risk Assessment* and its *Addendum* (EPA 1998a and EPA and ATSDR 2001). The Selected Remedy addresses these risks in a manner consistent with CERCLA and the NCP.

Under normal hydrologic conditions, approximately 60 percent of the copper load in the river's surface water is from streambank erosion, with smaller contributions from other sources, such as floodplain runoff and groundwater discharge, that together contribute about 12 percent. Although the contribution of floodplain runoff is itself only about 6 percent of the total copper load, it is the principal source of dissolved copper during pulse or storm events and presents the most severe threat to aquatic life. The Selected Remedy removes exposed deposits of tailings (slickens), treats in-situ impacted soils and vegetation, maximizes the re-establishment of vegetation that can provide stability to the banks of the river, and significantly reduces environmental hazards arising from movement of contaminants via floodplain runoff. The Selected Remedy also increases the stability of the floodplain and reduces environmental risks that arise during flood events.

EPA, in consultation with DEQ, considers general program goals and expectations found in the NCP at 40 CFR § 300.430(a) when proposing a preferred remedy and ultimately selecting a final remedial action. Section 430(a)(1)(iii)(A) and EPA guidance states EPA's expectation that principal threat wastes will be addressed with reliable "treatment." For mobile waste in floodplains associated with acute risks, such as the exposed tailings and phytotoxic streambanks, this means removal and permanent disposal outside of the floodplain. Section 430(a)(1)(iii)(F) emphasizes the importance of restoring groundwater to beneficial uses or, at least, preventing migration and exposure to contaminated groundwater. The Selected Remedy, through removal of most of the slickens areas, better achieves ARARs compliance and provides for a more long-term and permanent remedy. Section 430(a)(1)(i) describes an important goal of maintaining protection over time, and the slickens removal and streambank and riparian corridor portion of the remedy is the best suited among the streambank protection options to meet this goal.

The Selected Remedy was chosen because of the following analysis of Threshold, Balancing, and Modifying Criteria:

- It provides for overall protection of the environment through incorporation of streambank and riparian corridor stabilization, and removal/treatment of exposed tailings and mixed soils.
- It provides for long-term effectiveness and permanence by removal of slickens (in most cases), in-situ treatment of impacted soils and vegetation, and vegetative stabilization to curtail excessive erosion.
- It provides for a reduction of toxicity, mobility, and volume through removal of slickens to a local repository, in-situ treatment of impacted soils, and application of in-situ techniques for stabilizing streambanks.
- It provides for short-term effectiveness by utilizing in-situ treatment where appropriate, helps shorten the implementation time for the remedy, and reduces truck traffic and associated safety concerns. Sequencing of activities at different locations throughout the river corridor will promote an efficient and timely remediation schedule, and will help to maintain the integrity of the floodplain should an extreme flood event occur during the remedial action period.
- It provides an implementable approach to the remedy, which is technically and administratively feasible, and can be supported by a local resource pool of equipment, specialists, and materials, including a viable location for depositing wastes.
- It provides a cost effective approach to complete a protective and permanent remedy in a reasonable period of time.
- It provides for some flexibility in design to address significant landowner concerns, and it has received State concurrence, as described in the State's concurrence letter (Appendix F).
- It addresses many concerns raised in the public comment period (see Section 15, page 2-159, and Part 3, *Responsiveness Summary*) and tries to balance the many views received from the commenters on the *Proposed Plan*.

The proposed removal of slickens, in most cases, with in-situ treatment of impacted soils and vegetation areas, promotes overall protectiveness and long-term effectiveness. This balanced approach reduces potential reliance on long-term BMPs, ICs, and monitoring and maintenance. Use of in-situ treatment for significant portions of the impacted soils and vegetation areas will lessen short-term safety risks and environmental impacts, and allow for a shorter remedial action construction period. The Selected Remedy approach is implementable and cost effective. EPA intends to address concerns regarding the length of time and the intrusiveness of remediation through careful sequencing of actions, application of a combination of remedial techniques, and coordinating concurrent cleanup at various areas. Through these actions, the Selected Remedy strives to meet the remedial action objectives set for floodplain tailings and impacted soils, groundwater, and surface water.

13.2 Overview of the Selected Remedy

As previously noted, the *Proposed Plan* contained a preferred remedy that consisted of a combination of various technologies. These technologies were previously described as portions of other alternatives in the Clark Fork River *Feasibility Study*. The preferred remedy was composed principally of certain components contained in Alternatives 5D, 4B4, and 6C. It most closely resembled Alternative 5D. The preferred remedy proposed a combination of remedial technologies including the following:

1. Stabilizing eroding streambanks and providing an approximately 50-foot wide protective riparian corridor on both sides of the river
2. Removal of exposed tailings or slickens to a central disposal area and replacement with clean soils
3. In-situ treatment of areas of impacted soils and vegetation
4. Necessary revegetation of the riparian corridor and other treated or removal areas

The preferred remedy was proposed to be implemented along the erosive streambanks and the historic 100-year floodplain of virtually all of Reach A, and in small, localized areas of Reach B. Following the public comment period for the *Proposed Plan*, and taking the various comments received into consideration, EPA has determined the Selected Remedy for the Clark Fork River OU.

The Selected Remedy is comprised of the following:

- The *Record of Decision* defines exposed tailings areas. Exposed tailings will be removed, backfilled with cover soil, and revegetated, with a limited exception. The limited exception is: exposed tailings that are 400 square feet or less, less than approximately 2 feet deep, and contiguous with impacted soils and vegetation areas that will be treated in-situ. When these conditions are present, in-situ treatment will be applied.
- The *Record of Decision* defines areas of impacted soils and vegetation. The areas of impacted soils and vegetation will be treated in place, using careful addition of lime and other amendments, soil mixing, and re-vegetation.
- Some impacted soils and vegetation areas will instead be removed where depth of contamination prevents adequate and effective treatment in place or where saturated conditions make in-situ treatment unimplementable; or post-treatment arsenic levels would be above the human health action level after one re-treatment for the current or reasonably anticipated future land use. Further definition of the exceptions for depth and saturation is contained in Section 13.3, page 2-85.
- Streambanks will be stabilized by "soft" engineering (and hard engineering techniques, when warranted) for those areas classified as Class 1 or Class 2 streambanks, and an approximate 50-foot riparian buffer zone will be established on both sides of the river. This will lessen the high rate of erosion and contaminant input from streambanks, and will prevent or reduce the uncontrolled release of contaminants and potential stream braiding during flooding. Stream stabilization techniques are further described in Section 13.6.4, page 2-106, and include an emphasis on protecting against shear stresses

on unstable banks. Subsequent remedial design activities will define the most practical and effective methods and the exact location for streambank stabilization. The riparian buffer zone width will be flexible and considerate of landowner concerns and the nature of the stream at a given location.

- The removed wastes will be conveyed to the Opportunity Ponds for proper placement and/or disposal. Closure of the Opportunity Ponds will be accomplished under the authority of the Anaconda Regional Water, Waste, and Soils Remedial Design/Remedial Action (RD/RA).
- Weed control for in-situ treatment, streambank stabilization, and removal areas is an important component of the Selected remedy. It is further described in Section 13.10, page 2-123.
- BMPs will be used throughout Reach A and in limited areas of Reach B to protect the remedy. BMPs will be contained in landowner specific plans, and will be used to ensure land use practices are compatible with long-term protection of the Selected Remedy.
- ICs and additional sampling, maintenance, and possible removal or in-situ treatment of contamination will be required to protect human health. The trestle area in Deer Lodge is a recreational area that will be addressed under the *Record of Decision*. Specific institutional controls identified as necessary are as follows: continued Anaconda and Deer Lodge County zoning regulations (prohibits building a permanent residence within the Clark Fork River floodplain), deed restrictions and permanent funding for Arrowstone Park, and groundwater use controls to prevent domestic consumption of contaminated groundwater.
- Monitoring during construction, construction BMPs, and post-construction environmental monitoring will be required.
- Continued removal of arsenic contamination in the East Side Road area as needed and further evaluation of irrigated land for human health reasons.

Because NPS has specific cleanup needs and responsibilities under the laws that govern National Historic Sites, such as the Grant-Kohrs Ranch National Historic Site, the remedy is modified and expanded in this *Record of Decision* for this area. Those components of the *Record of Decision* are described in Section 13.7, page 2-107.

The Selected Remedy will be implemented along the erosive streambanks and the historic 100-year floodplain of virtually all of Reach A and small, localized areas of Reach B. The remedy for Reach C is no action.

Implementation of the Selected Remedy will be initiated with the RD/RA phase of the project. Each property will be surveyed to refine the surface topography, and then evaluated utilizing the CFR RipES tool. CFR RipES is a special assessment process developed as a detailed design tool specifically for the Clark Fork River OU that determines differing erosive conditions and lengths of streambanks, notes pertinent detail regarding existing riparian corridor conditions, and defines and locates specific areas of exposed tailings or slickens, and areas of impacted soils and vegetation to the edges of the floodplain. This critical data and information will then be mapped in conjunction with the refined topographical information. Landowners will be consulted on certain design elements and allowances will be made for implementation of natural resource damage actions and/or consideration of Department of Agriculture programs.

Sufficient, detailed information will then be available to develop a site-specific design for a particular property. Necessary design elements will include the following:

- Landowner communication, overview of land use (desired and current), and interaction of remedy components onto property overlay.
- Specific locations and areas of slickens, and other areas slated for removal, including depths of tailings that defines the required excavation depths and volumes of removed material.
- Amounts of clean fill that will be required to backfill excavated areas.
- Lengths, locations, and erosive conditions of various classes of streambanks, both on the river and along associated tributaries, to permit the utilization of site-specific designs to stabilize the various eroding portions of the streambanks.
- Information for laying out the required routes and design specifications of necessary temporary haul roads and bridges.
- Establishment of liming and other amendments requirements, and areas and depths of mixing for in-situ treatment of impacted soils.
- Establishment of revegetation designs for both the riparian corridor and remaining floodplain areas.

Once the property design is completed, with input from the property owner, and approved by the implementing agency, the remedial action or implementation phase (i.e., the construction phase) planning and scheduling can begin.

13.3 General Clean-up Strategy

The general clean-up strategy involves the following components:

- The human health provisions as defined in Section 13.4, page 2-87, will be implemented as a priority, following remedial design for this component.
- EPA and DEQ will seek cooperation of all landowners on the river to apply the CFR RipES evaluation tool for their particular property. At the beginning of the CFR RipES process, each landowner will be interviewed and preliminary design issues and concerns they may have will be discussed and notations made. Upon completion and evaluation of the CFR RipES property data, and acquisition of specific design information, the landowner will be advised of the preliminary site specific design for their property and can provide input to the final design for their individual property. Final design decision will be made by the agency.
- Exposed tailings, referred to as slickens, will be removed, with a limited exception. Slickens that are less than 400 square feet and less than 2 feet in depth and not too wet will be treated in-situ if they are next to or contained within an impacted soils and

vegetation area that is designated to be treated in-situ. These small slickens within or next to areas to be treated in-situ will be removed if they are thicker than 2 feet or too wet to treat. Areas of healthy vegetation that contain isolated small slickens will not be disturbed by trying to access and remove the small slickens. This will allow the established soil-binding vegetation to be preserved. These areas will be treated in-situ if practicable.

- Impacted soils and vegetation areas will generally be treated in-situ, unless certain exceptions apply. Areas of impacted soils and vegetation that have tailings and impacted soils extending deeper than 2 feet will be removed rather than treated in-situ. Such areas will also be removed if they are too wet to effectively treat in-situ.
- Old oxbow channels and wetlands will be evaluated by CFR RipES. If they have high quality vegetation they will not be remediated. If they have impacted vegetation and the contaminated tailings and soils are deeper than 2 feet or the soil is too wet, they will be removed and replaced in a manner that re-establishes a productive and healthy wetland. If the tailings and contaminated soils in these impacted areas are less than 2 feet in an old oxbow channel and it is not too wet, the area will be treated in-situ (see Section 13.8.3, page 2-119).
- Irrigation ditches that conveyed historically contaminated water will be sampled through a representative sampling program to be developed to ensure that contaminant concentrations do not cause unacceptable risks to human health or the environment, as further described in Section 13.8.3, page 2-119.
- The three classifications of eroding streambanks defined previously will be identified by CFR RipES and the appropriate site-specific designs developed for each. Streambank erosion will be controlled using appropriate bio-treatment methods relative to each erosive class. The associated riparian corridor vegetation, the soils of which can be remedied using removal and in place techniques, will then be supplemented with the additional plantings of various sized deep, binding woody vegetation, primarily sandbar willows.
- Weed management will be a high priority consideration during all remedial design activities, and during implementation of the remedy. BMPs will be utilized during construction and post construction to protect the water quality of the river, air quality, and other adjacent critical assets of the landowner, including existing vegetation. Construction and post construction monitoring of water, air, soil, vegetation, and other environmental parameters will be required. Land use BMPs will be developed in conjunction with each landowner to ensure long term protectiveness.

The agencies will work with the Conservation District and other agencies to ensure that the land use BMPs are consistent with good land use practices employed by the landowner, both short and long term. Continued enforcement of human health protective ICs, continued monitoring and maintenance of appropriate environmental media, including all remediated recreational, farming/ranching and residential locations throughout Reaches A and B, will be required. Responsibility for the enforcement of BMPs, which will be monitored through oversight activities, will be an important issue that will need to be addressed as outlined in Section 13.6.5, page 2-107.

13.4 Selected Remedial Actions to Address Human Health Risks and Pathways

The actions required to address human health considerations are as follows:

1. The Selected Remedy sets action levels for arsenic in soils within the Clark Fork River OU:
   - Residential – 150 ppm
   - Rancher/Farmer – 620 ppm
   - Recreational – 680 ppm for children at Arrowstone Park and other similar recreational scenarios, and 1,600 ppm for fishermen, swimmers, and tubers along the river only.
2. The trestle area in Deer Lodge was identified by ATSDR as an area where current data indicates an exceedance of the recreational level established above. Early sampling of this area shall be undertaken as needed to supplement existing data. If levels identified above for recreational exposure (680 ppm arsenic) are exceeded, contaminated soils will be removed and replaced with appropriate backfill, and revegetation shall be implemented. Disposal of excavated materials will be in Opportunity Ponds. Other known recreational areas will be evaluated, using existing data where possible, to determine if they exceed the recreational level. If exceedances are found, they will be dealt with in a similar manner.
3. The NPS provided a risk assessment indicating potential risks to workers from arsenic contaminated irrigation ditches at the Grant-Kohrs Ranch National Historic Site. Additional sampling will be performed in coordination with the NPS to determine if unacceptable risks are present, and, if so, contamination will be removed and disposed of at Opportunity Ponds.
4. Some residences are identified under the Deer Lodge Valley Historically Irrigated Lands TCRA as exceeding the action level for arsenic in residential areas and were not addressed under the TCRA. These areas will be revisited and remediated consistent with that action. Other follow-up operation and maintenance activities from this action will be implemented.
5. EPA does not believe that other historically irrigated lands within the Clark Fork River OU exceed EPA's action level for reasonably anticipated land use for those lands. This shall be confirmed via sampling of these lands if necessary and confirmation that residential development is not planned for these areas. As noted in later portions of this section, confirmation sampling for in-situ treated areas is also required to ensure that these areas are below action levels for current and reasonably anticipated uses (which is likely to be agricultural for most lands) after treatment.
6. Three ICs will be implemented to further protect human health:
   - Continued implementation, including funding, will be provided for Powell County's and Anaconda Deer Lodge County's zoning ordinances, which

prohibits building a permanent residence within the floodplain of the Clark Fork River in that county. Since this IC does not prevent residential yards within the floodplain associated with residences just outside of the floodplain, the county will be funded to monitor and report on any such use. Appropriate remedial action will be taken if such yards are found or created, and if arsenic levels exceed EPA's residential action level.

– Permanent deed restrictions and use funding are required for Arrowstone Park near Deer Lodge, to ensure that this area is maintained and dedicated for use as a recreational area.

– All previously sampled domestic wells that exceeded MCLs will be resampled, as well as any new private domestic well located in or near the floodplain. Appropriate ICs to address groundwater use in the shallow aquifer shall be implemented and funded. A survey of well use in the floodplain of Reach A is necessary. Domestic wells identified that are near contamination sources will be sampled, and appropriate action to ensure safe water supplies for domestic users will be taken if exceedances of groundwater performance standards (which for domestic wells will be based on total, rather than dissolved, analysis) are found. Additional ICs beyond existing State statutory protections can range from ground water control areas through the State Department of Natural Resources and Conservation (DNRC) to ordinances or deed restrictions. The exact nature of this IC component will depend on land use and contamination severity.

7. Educational efforts for recreational users within the river corridor area, concerning the need to prevent soil intake by children and maintain other health practices to prevent unnecessary exposure to soils, shall be undertaken or funded, in cooperation with local and State health authorities.

Some locations within the riparian area possibly contain soils or tailings at treatable depths with mean arsenic levels that may exceed 620 ppm when mixed. According to the *Remedial Investigation*, the geometric mean arsenic level (25 and 75 percentile levels) for tailings in Reach A is 766 ppm (483 and 1,134 ppm). The remedial action for barren tailings is removal, so exposure to arsenic from barren tailings will be eliminated. Samples of mixed soils and tailings have arsenic concentrations of 419 ppm (geometric mean), with 25 and 75 percentile levels of 190 and 1,532 ppm. It is possible that some of these areas will also be removed as part of the remedial action if in-situ treatment does not obtain low enough (mixed soil) profile arsenic levels. All areas scheduled for in-situ treatment will be pre-sampled and post-sampled for arsenic to ensure the treatment will meet arsenic action levels. If the exposure unit (usually the treated area) exceeds the health-based action level, the area will be retreated. If the exposure unit still exceeds the action level after one re-treatment, the area will be removed. Under the Selected Remedy, previously treated areas will be re-evaluated to determine if additional treatment or removal is needed. Levels of surface soil arsenic in treated areas are generally expected to be below the human health RBCs for the farmer/rancher, the recreational user, and the swimmer/rafter.

As the ATSDR suggested, EPA evaluated this pathway and believes that the Selected Remedy, which provides for streambank stabilization, removal of the slickens areas, and treatment of areas with moderately dysfunctional plant communities (impacted areas), will provide protection to recreational users. Development of any future recreational areas, or areas known now to be recreational areas, must ensure that contaminant levels in soil are reduced below the recreational RBCs of 680 ppm for chronic exposure to children aged 1 to 10, and 1,600, ppm for swimmers and rafters. Residential areas within the TCRA area that have not yet been addressed will be assessed using the residential soil action level of 150 ppm.

13.5 Selected Remedial Actions to Address Environmental Risks and Pathways

Based on ecological studies conducted within the Clark Fork River OU, especially the *Ecological Risk Assessment* (EPA 1999), EPA determined that widespread unacceptable terrestrial and aquatic risks exist in Reach A and portions of Reach B. Areas of primary concern are phytotoxic soils and subsequent lack of or reduced vegetation, impacts on livestock and wildlife, and unacceptable risks to aquatic receptors, principally benthic macroinvertebrates and fish.

13.5.1 Acute Aquatic Risks

EPA recognizes the importance of both acute and chronic aquatic risks in selecting the remedial action, and identified removal of slickens and in-situ treatment of less impacted contaminated areas, along with significant streambank stabilization, as an appropriate and balanced means to address these risks. Historically, there has been a clear association between storm events and the occurrence of fish kills in the Clark Fork River. This is thought to be due to surface water run-off from exposed tailings areas, since these surface flows generally contain high concentrations of copper and other metals, and are also acidic. Maximum concentrations in runoff water from barren slickens were reported to be 7,380 mg/L copper, 2,350 mg/L zinc, and 23 mg/L arsenic (Atlantic Richfield Company 1997). In this regard, it is important to note that not all storms cause acute lethality. Rather, the key factor appears to be the formation of metal salt crusts on the tailings, which in turn requires an appropriate set of meteorological conditions to form initially. In a review of a major fish kill in 1989, it was postulated that concentrations of metals in these salts, in readily soluble form, were responsible for rapid increases in river water metal levels, and subsequently the lethal concentrations of metals, especially copper, in fish tissues (Munshower et al. 1997). Because tailings are the principal waste or source material (barren slickens and reoccurring metal salts), and because run-off waters from exposed tailings are known to contain very high levels of metals and are acidic, it is concluded that the risk of acutely lethal pulses remains unless these source materials, or principal wastes, are removed.

Removal of barren slickens areas, which produce these soluble metal salts that can then be washed into the river during storm events, will eliminate this potential acute risk to aquatic receptors.

13.5.2 Chronic Aquatic Risks

In the *Ecological Risk Assessment* (EPA 1999) several factors and investigation results relating to chronic risks to Clark Fork River fish were evaluated. These included chronic exposure to contaminated surface waters, site-specific fish survival tests, avoidance studies, exposure to contaminants from diet and from sediments, and comparative fish density studies. In a recent laboratory fish feeding study (Stratus 2002), juvenile rainbow trout were fed live diets exclusively of *Lumbriculus variegatus* (common names include California blackworm, blackworm, and mudworm). The *Lumbriculus* were cultured in metal-contaminated sediments collected from Silver Bow Creek and the Clark Fork River. Significant growth inhibition was reported for fish fed the contaminated diets over the 67-day trial period. Growth inhibition was statistically related to metals and arsenic in the diets and to levels found in fish tissues. The best statistical correlations were reported for arsenic. The study suggests that *Lumbriculus variegatus* grown in metal-contaminated sediments can pose a risk to juvenile rainbow trout through an exclusive dietary exposure pathway. Taken together, the data from these studies are consistent with the hypothesis that copper (and possibly arsenic and other metals) in the aquatic environment (surface water, diet) impose low-level chronic stress on aquatic macroinvertebrates, trout, and other fish.

EPA's Selected Remedy is an appropriate response to these unacceptable acute and chronic risks to Clark Fork River fish. The removal of most barren slickens areas addresses the principal waste and acute risk in a permanent manner without residual risk. The in-situ treatment component addresses other impacted soils and vegetation and related terrestrial risk found at the site. The streambank stabilization component addresses the erosion, stream stability, and chronic aquatic risks found at the site.

13.5.3 Livestock and Wildlife

The Ecological Risk Assessment (EPA 1999) predicted the overall hazard to range cattle to be moderate. The primary source of the risk is from ingestion of copper from soil, not from normal drinking water sources. See Section 7.2, page 2-42, for additional risk discussion.

13.5.4 Terrestrial Vegetation

Mining wastes prevalent in denuded streambanks are generally phytotoxic as demonstrated by the many barren slickens areas and areas of impacted vegetation, which support limited plant species and provide low agricultural production. The Selected Remedy is a combination of slickens removal, treatment of impacted areas, and streambank stabilization. Establishing appropriate woody and herbaceous vegetation is key to the success of the Selected Remedy. Reduction or elimination of phytotoxic conditions will be accomplished by removal of principal threat wastes (barren slickens), treatment of areas with vegetation communities impacted by contamination, and establishment of deep binding root mass along the river's banks. Woody vegetation on meander tabs will reduce overland erosion within the riparian buffer zone and help stabilize the tabs so that meander cutoffs do not occur at accelerated rates. The Selected Remedy provides a mix of mature and less mature vegetation within the newly established riparian corridor to ensure short-term and long-term geomorphic stability along the river. The buffer corridor with deep, binding woody vegetation will reduce erosion, contaminant loading to the river, and sedimentation.

Excavation of tailings and replacement with cover soils that meet specific chemical, physical, and biological requirements, followed by establishment of vegetation appropriate for the land use, will be implemented on approximately 170 acres. In-situ treatment involves the addition of neutralizing amendments to control acidity and reduce bioavailability of metals. Other amendments, such as phosphorus to minimize arsenic mobility, may be considered as part of the remedial design. When soil arsenic levels exceed 1,000 mg/kg measured before treatment, additional phosphorus is to be incorporated into the treatment zone. Both organic matter and fertilizer are added to develop a hospitable rootzone. Vegetation appropriate for the land use will be established on these treated areas currently estimated to be 700 acres. Vegetation established on both cover soil and treated areas as well as within the riparian corridor, will reduce wind and water erosion, thus reducing the movement of metals in dusts and surface water runoff. The quality of the runoff water will also be markedly improved. Increased vegetation will maximize infiltration while plant use of water will reduce deep percolation, thereby reducing the flux of contaminants to groundwater.

13.6 Detailed Description of the Selected Remedy

The detailed description of the Selected Remedy is provided in this section by subject area.

13.6.1 The Selected Remedy, CFR RipES, and the Landowners

Nearly 100 landowners live along the Clark Fork River within Reach A, where most of the cleanup is expected to occur. However, more than 71 percent of the Clark Fork River streambanks in Reach A is owned by 14 landowners. Implementation of the Selected Remedy is estimated to require approximately ten construction seasons to complete. Implementation of the Selected Remedy will create both short and long term impacts for each affected landowner. Short term impacts, typically up to 2 years in duration (or possibly longer for larger property owners), will be created during the additional data gathering, design, and construction phases required for implementation of this remedy. The design and construction of the Selected Remedy phases will be carefully coordinated with the landowner and executed in such a manner as to minimize impacts to the landowner. Weed control will be a highlighted concern addressed during remedial design.

As mentioned previously, BMPs will be utilized during construction. Some typical examples of construction BMPs include wetting haul roads and excavated materials and using covered haul trucks to minimize dusting, using silt fencing and straw bales for filtering rain water runoff prior to entering a drainage ditch or the river, and not operating during high winds to avoid generating excessive dust. After construction is completed, establishment of longer term BMPs and land use practices will be contained in a property management plan that may include riparian corridor restrictions, a weed management program, a grazing management plan, an irrigation plan, and other management actions. These post-construction BMPs, which will impact the landowner, are necessary to protect the success of the remedy, both short and long term. Maturation of herbaceous vegetation will require up to 3 years; maturation of woody vegetation to provide the necessary streambank erosion protection will require up to 10 years, depending on vegetation performance. After 10 years, management plans may be modified appropriately.

To implement the Selected Remedy, EPA and DEQ will seek the cooperation of each landowner on the river to allow access to evaluate the landowner's property. This property-by-property analysis will be conducted using the CFR RipES evaluation tool and will include gathering additional topographic and other survey data. In this initial meeting, additional information will also be obtained from the landowners that will be considered during the remedy design and implementation process for their property. Other topics may be discussed, such as minimizing impacts on ranch operations, future monitoring and maintenance activities, maximizing future land productivity, the short and long term implications regarding the uses of BMPs, construction methods, procedures and safety practices, interim land uses, interim irrigation practices, and other issues.

Upon completion and evaluation of the data obtained from the CFR RipES process on a particular property, preliminary detailed designs that are consistent with the Selected Remedy can then be developed for each remedial component of the Selected Remedy applicable to said property. The landowner will then be advised of this preliminary site-specific design, and through additional discussion, provide any additional input. The implementing agencies' goal will be to seek voluntary access and a design plan agreement for each landowner.

Subsequent to the implementing agency's approval of a final detailed design, construction would be scheduled in the most efficient way to minimize the amount of time and disruption on the landowner's property.

13.6.1.1 CFR RipES

Overview. CFR RipES is a tool that allows the *Record of Decision* requirements to be implemented on a site-specific, refined, and definitive basis. The purpose of CFR RipES is to provide a data predicated decision tool to identify and categorize polygons (delineated areas of land) based on landscape stability and plant community attributes within the Clark Fork River OU. CFR RipES will be used to make classifications and determine actions consistent with the standards set forth in the *Record of Decision*. The system contains the following elements:

- Definitions and scoring for three types of soils polygons and three types of streambank and riparian corridor buffer polygons
- A 100 percent accounting of all areas in the historic 100-year floodplain within the Clark Fork River OU among the three types of soil polygons in Reach A and portions of Reach B
- Numerical components with threshold scores that distinguish the severity of contamination of the floodplain soils, and thresholds that separate streambank riparian corridor buffer polygons into three classes
- A process for identification of data and information required to complete remedial designs for each polygon

The numerical portion of the system is based upon the Land Reclamation Evaluation System (LRES) developed for the Anaconda Smelter NPL Site (EPA 1998b, CDM and RRU 1999, and Atlantic Richfield Company 2000b), and the Riparian and Wetland Health Assessment protocols (Hansen et al. 1995 and 2000), which are used extensively in the western United States and Canada. The health assessment protocols (Hansen et al. 1995 and 2000), upon which the numerical evaluation of the ecological aspect of CFR RipES is based, were initiated in 1986 in a series of iterative steps wherein inter-disciplinary teams of natural resource professionals and scientists collaborated using the Delphi Method or Expert

Opinion Method (Delbecq et al. 1975, Schuster et al. 1985) to write, field-test, and refine the protocols.

This document describes the CFR RipES system in relation to the CERCLA RI/FS process and the CERCLA RD/RA process. It builds on the initial CFR RipES document (RRU and RWRP 2000) and integrates the thinking and rationale supporting the selected remedy as stated in this *Record of Decision*. CFR RipES will also be used to establish performance standards, evaluate land reclamation designs, evaluate post-action effectiveness, and in monitoring and maintenance programs for reclaimed areas.

Structure. Areas within the Upper Clark Fork River floodplain are classified for purposes of determining specific remedial actions based on landscape stability, contamination, and plant community dysfunction. Of first concern are those areas most in jeopardy of being eroded into the river channel. The OU is divided into smaller units of land, called **polygons**, which are delineated and classified as candidates for the various kinds of treatment.

Four major types of sites are defined below for the purpose of identifying areas for the various remedial actions:

1. Streambank and riparian corridor buffer
2. Slickens areas (exposed tailings)
3. Impacted soils and vegetation areas
4. Slightly impacted soils and vegetation areas

Miscellaneous types are also identified (i.e., irrigation ditches, contaminated upland areas, tributary streams, etc.), and remedial actions for these are defined in this document. Characteristics of the major types of sites and remedial actions for each type are provided below.

Streambank and Riparian Corridor Buffer. The streambank and riparian corridor buffer is a zone of approximately 50 feet in width on each side of the river that may vary in width, depending on site-specific conditions. For example, a severely eroding outer streambank may require more than 50 feet, while on inside banks with point bars and along straight reaches of the stream where the erosive forces are minimal, the corridor may be less. For cost analysis in the *Feasibility Study*, a 50-foot zone was used along the entire stream corridor. Appendix B, *Clark Fork River OU Streambank Stabilization Design Considerations and Examples*, contains figures illustrating erosional processes and remedies.

The streambank and riparian corridor buffer is delineated by measuring from the "bankfull" stage on each side of the stream out a flexible or variable distance (see preceding paragraph), ***or*** where the historic 100-year floodplain elevation is reached. In other words, areas outside the historic 100-year floodplain are not included in the streambank and riparian corridor buffer. In cases where high banks are reached, the buffer may be narrower. Bankfull flow for the Clark Fork River at Deer Lodge has been calculated to be about 1,900 cfs (Griffin and Smith 2001). This equates to approximately a 7-year flood event. At this stage, the flow begins to spill out of the channel and disperse onto the floodplain.

The approximate 50-foot streambank and riparian corridor buffer zone on each side of the river will be broken into preliminary polygons based on live vegetative canopy cover, canopy cover of deep, binding, woody vegetation, and/or lengths of streambank erosion.

The minimum mapping unit of these polygons is 20 linear feet of streambank with a maximum length of 500 feet. Polygon units will not cross land-ownership boundaries. These polygon units will be scored using the CFR RipES Field Form for Streambank and Riparian Corridor Buffer Polygons, thereby classifying streambanks into one of three categories designated as Class 1, 2, or 3 streambanks.

- **Class 1 Streambanks**—Phytotoxic conditions exist as demonstrated by inability of the active channel areas to support and sustain significant amounts of woody and herbaceous vegetation. Streambanks are actively eroding and are significant contributors to contaminant release to the river. Remedial actions for this class include removal of phytotoxic materials and revegetation with deep, binding, woody vegetation. These actions will be implemented from a line at the lateral extent of inundation at bankfull stage out to approximately 50 feet from that line. Specific actions at a Class 1 streambank will be determined in accordance with *Record of Decision* specifications and after consideration of site-specific design factors. Site-specific design factors include depth of removal (this is not necessarily the same as depth of contamination), depth to the water surface, depth to groundwater, current streambank stability, current vegetation status, infrastructure (bridges, culverts, etc.), surface drainage, future land use, BMPs, and others.
- **Class 2 Streambanks**—Generally non-phytotoxic conditions exist as demonstrated by some current woody and herbaceous vegetation, but streambanks are contaminated, not stable, and are eroding. Remedial actions for this class include supplemental revegetation and planting of deep, binding, woody vegetation. Reconfiguration of the streambanks may require minor removal or in-situ treatment. Design factors include current streambank stability, current vegetation status, infrastructure, surface drainage, future land use, BMPs, and others.
- **Class 3 Streambanks**—These streambanks are contaminated but they may have varying amounts of deep, binding, woody vegetation holding the streambank in place. Remedial actions possible for these areas include no action or minor actions to enhance woody vegetation within the buffer corridor and/or BMPs. Design factors include current vegetation status, current streambank stability, knowledge of underlying contamination, and current and future land use.

Special Cases: Tributary Systems and Secondary Channels. Streambank and riparian corridor buffer polygons will be delineated for evaluation and classification for appropriate remedial actions on sites beyond the main channel of the Clark Fork River within the OU. These are tributary streams and secondary channels of the Clark Fork River. These “special case” sites may be classified as Class 1, 2, or 3 streambanks with the application of CFR RipES.

- **Tributary streams—**Tributaries within the OU (e.g., Lost Creek, Warm Springs Creek, Dutchman Creek, Racetrack Creek, Cottonwood Creek, and others) may have transported contaminants from other NPL sites in the basin, or may have been contaminated during depositional flood events from the Clark Fork River. Tributaries having perennial flow will be protected with a streambank buffer 25 feet wide within the OU, unless this width extends outside the historic 100-year floodplain of the Clark Fork River.

– **Secondary channels of the Clark Fork River—**Also of concern are secondary channels forming islands on the Clark Fork River floodplain. Secondary channels with perennial flow throughout their length and having connection to the main channel of the river at both ends will also be protected with a flexible or variable streambank and riparian corridor buffer of 25 feet, unless this width extends outside the historic 100-year floodplain of the Clark Fork River.

Historic 100-Year Floodplain Contaminated Soils. Contaminated soils within the historic 100-year floodplain may consist of slickens, impacted soils and vegetation areas, or slightly impacted soils and vegetation areas.

Slickens (exposed tailings). These areas generally lack vegetation (have less than 25 percent canopy cover) and present the principal waste in the Clark Fork River OU, along with Class 1 Streambanks. Estimated in the RI/FS at about 167 acres, but possibly up to 250 acres in Reach A with limited slickens in Reach B, these slickens areas are contaminated, causing largely bare ground. Scattered throughout Reach A, the areas number in the hundreds, are usually a fraction of an acre in size, and are too toxic to support most vegetation or soil organisms. These areas are usually easy to recognize. Remedial action for most of these areas is removal, except as described below. Removal of slickens areas adjacent to an active channel is part of the streambank remedial action.

Slickens (exposed tailings) are characterized as follows:

1. Because of phytotoxic condition, these areas are generally devoid of vegetation, supporting less than 25 percent live plant canopy cover.
2. Tufted hairgrass (*Deschampsia cespitosa*) is present, if there is any live vegetation.
3. Efflorescent metal salts are visible on the soil surface during dry periods.

Slickens (exposed tailings) and underlying contaminated soil that meet these criteria will be removed, with a limited exception. For the exception to occur, all of the following criteria as defined by CFR RipES must be met:

- The slickens area is small—less than 400 square feet
- The contamination is less than 2 feet deep
- The contamination is widely dispersed or separated by vegetation
- The contamination is contiguous with impacted soils and vegetation areas that will be treated in place
- The area is not too wet or otherwise unable to be treated effectively

Slickens that are less than 400 square feet and less than 2 feet in depth and not too wet will be treated in-situ if they are next to or contained within an impacted soils and vegetation area that is designated to be treated in-situ. These small slickens within or next to areas to be treated in-situ will be removed if they are thicker than 2 feet or too wet to treat.

Isolated, small slickens areas (less than 400 square feet) that are not contiguous with impacted soils and vegetation areas will not be removed in most cases. These areas are too small to bring in removal equipment without significant destruction of the surrounding unimpacted areas. In-situ treatment will be done in these areas where practicable. These areas will also not be mapped under the CFR RipES protocols.

Impacted Soils and Vegetation Areas. Estimated in the RI/FS at about 700 acres, but possibly up to 1,760 acres in Reach A, these sparsely vegetated areas amount to everything between slickens and slightly impacted soils and vegetation areas that have an ecologically sound plant community. Impacted soils and vegetation areas will generally be treated in-situ, unless the tailings and impacted soils in a given area extend more than 2 feet below ground surface. In that case, the tailings and impacted soils will be removed. Other impacted soils and vegetation areas that are too wet for implementation of in-situ treatment techniques will also be removed. Old river channels (oxbows) and wetlands in the floodplain will be evaluated using CFR RipES. If they have high quality vegetation and score 75 percent or more on CFR RipES, they will not be remediated. If they have impacted vegetation and soils, and the contaminated tailings and soils are deeper than 2 feet, or the soil is too wet, they will be removed and replaced in a manner that re-establishes a productive and healthy wetland. If the tailings and contaminated soils are less than 2 feet deep in an old oxbow channel, and it is not too wet, the area will be treated in-situ.

Impacted soils and vegetation areas are characterized as follows:

1. The degree of phytotoxicity in these areas is quite variable, but they do sustain at least 25 percent live plant canopy cover.
2. Tufted hairgrass (*Deschampsia cespitosa*) has greater than 1 percent canopy cover.
3. Efflorescent metal salts may be visible on the soil surface during dry periods.
4. Small individual areas of exposed tailings (that appear as small slickens) may be present.
5. Concentrations of COCs within the soil profile exceed the geometric mean values for unimpacted soils for Reach A of the Clark Fork River OU. Copper is used as a surrogate for the COCs; soils with copper concentrations exceeding 300 ppm within the profile are considered impacted by mining-related activities.
6. The minimum polygon size is 400 square feet.

Slightly Impacted Soils and Vegetation Areas. These areas do not meet the characteristics or definitions of streambank and riparian corridor buffer, slickens (exposed tailings), or impacted soils and vegetation area. They are generally well vegetated and display no visible evidence of contamination from tailings, although the soil may contain copper contamination above 300 ppm. Remedial actions for these areas are no action, or BMPs and ICs. These may be included in a land management plan along with adjacent areas being addressed by the remedy.

Slightly impacted soils and vegetation areas are characterized as follows:

1. The area expresses no evidence of phytotoxicity and has less than 1 percent bare ground caused by contaminated tailings.
2. Tufted hairgrass (*Deschampsia cespitosa*) has less than 1 percent canopy cover.

3. No efflorescent metal salts are visible on the soil surface during dry periods.
4. Concentrations of COCs within the soil profile exceed the geometric mean values for unimpacted soils for Reach A of the Clark Fork River OU. Copper is used as a surrogate for the COCs; soils with copper concentrations exceeding 300 ppm within the profile are considered impacted by mining-related activities.
5. The minimum polygon size is 400 square feet.

CFR RipES Application. The characterization of contaminated soils above will account for the majority of land within the Clark Fork River OU that is to be considered for remedy. (CFR RipES is not applicable to the historically irrigated upland areas. Historically irrigated lands will be evaluated for human health risks and remediated if necessary, as described above.) After a polygon has been delineated using the delineation criteria described above, application of the flow-chart keys in Exhibits 2-20, 2-21 and 2-22 will provide the correct classification, and Exhibit 2-23 will indicate the correct subset of remedial actions from which to draw the remedial design.

Miscellaneous Site Types. There are several landscape areas or features that may contain contaminated materials by having one of the following:

1. Conveyed contaminated waters, i.e., drainage ditches
2. Contamination through historical irrigation, i.e., current or abandoned ditches
3. Subsequent separation of the historic 100-year floodplain from the present Federal Emergency Management Agency (FEMA) 100-year floodplain by human structures such as highways and railroads

These areas, with the exception of historically irrigated fields (which will be evaluated under the human health component), are to be considered in the remedial design. If this consideration shows soil contamination above action levels or impacted soils and vegetation communities, appropriate remediations will be designed for these areas.

These miscellaneous site types are further defined as:

1. Old river channels and oxbows that may be well vegetated, but may have thick deposits of buried contaminated tailings in contact with groundwater. (These sites do not meet the criteria for slickens or impacted soils and vegetation areas as defined in this document.)
2. Irrigation ditches, drainage ditches, and canals that may have conveyed contaminated waters and sediment. Irrigation ditches that conveyed historically contaminated water will be sampled through a representative sampling program to be developed to ensure that contaminant concentrations do not cause unacceptable risks to human health or the environment, as further described in Section 13.8.3, page 2-119.

EXHIBIT 2-20. Generalized Key for Categorizing CFR RipES Polygons

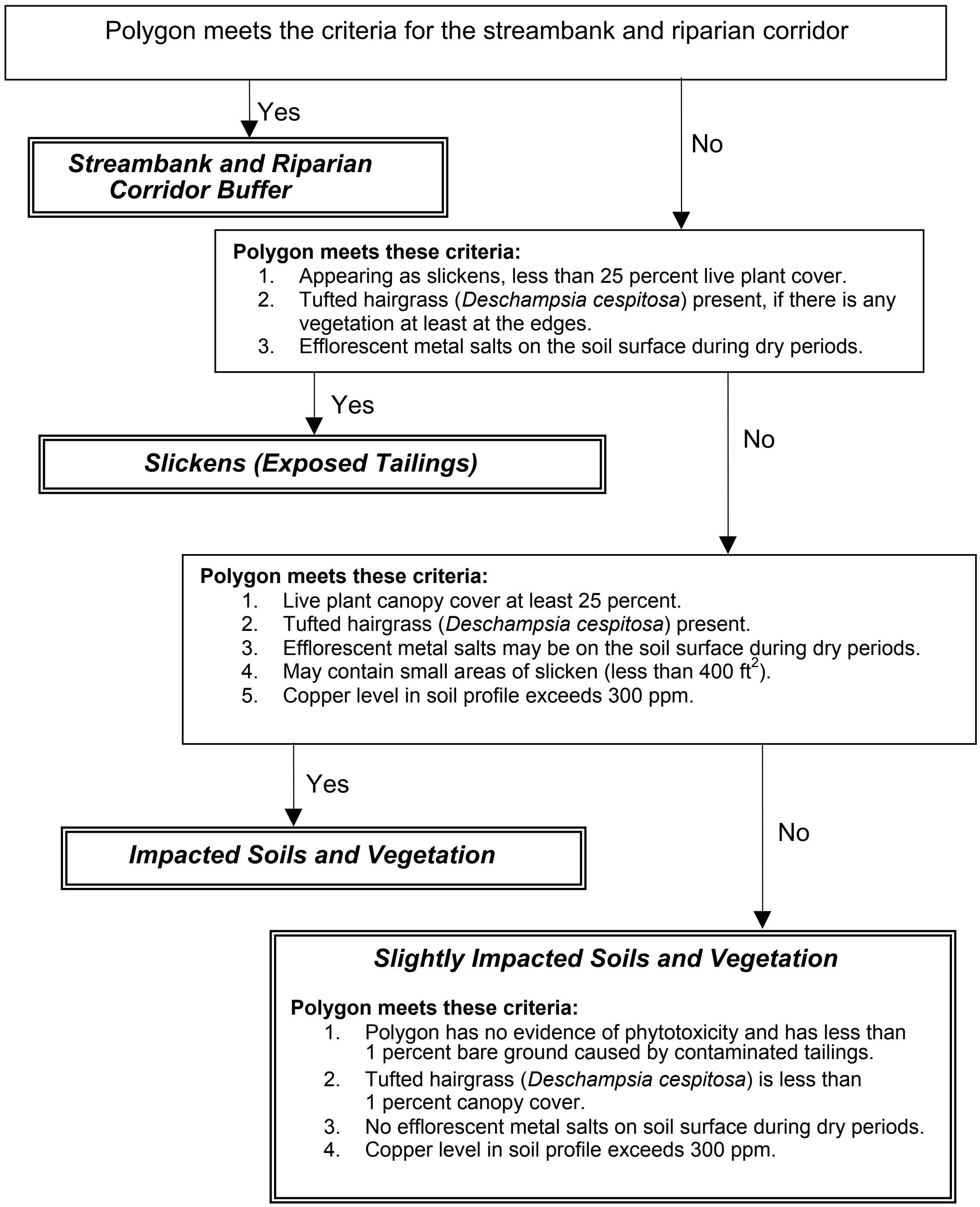

EXHIBIT 2-21. Polygon Characterization Within the Historic 100-Year Floodplain

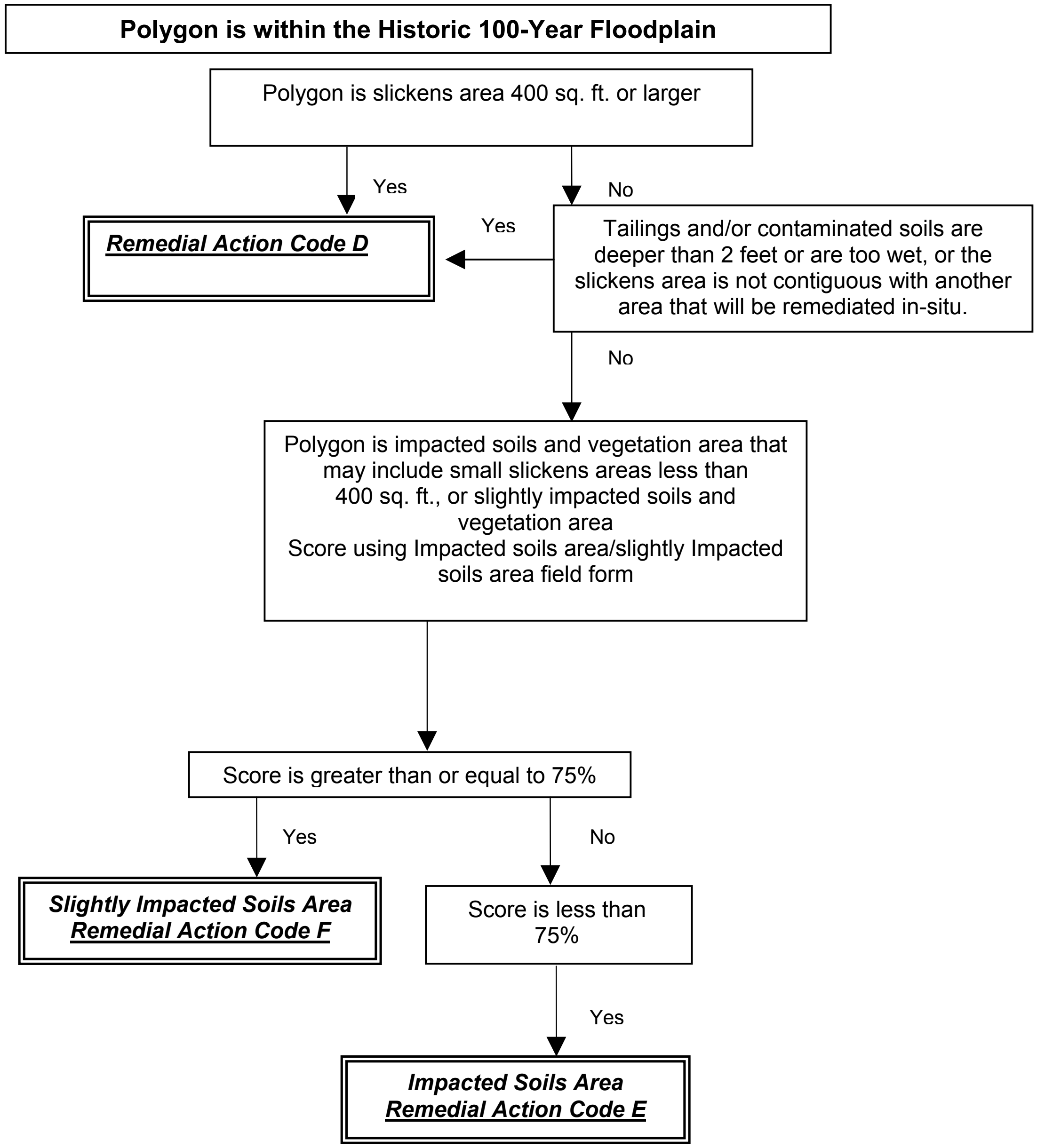

EXHIBIT 2-22. CFR RipES Polygon Categorization Within The Streambank Buffer Corridor

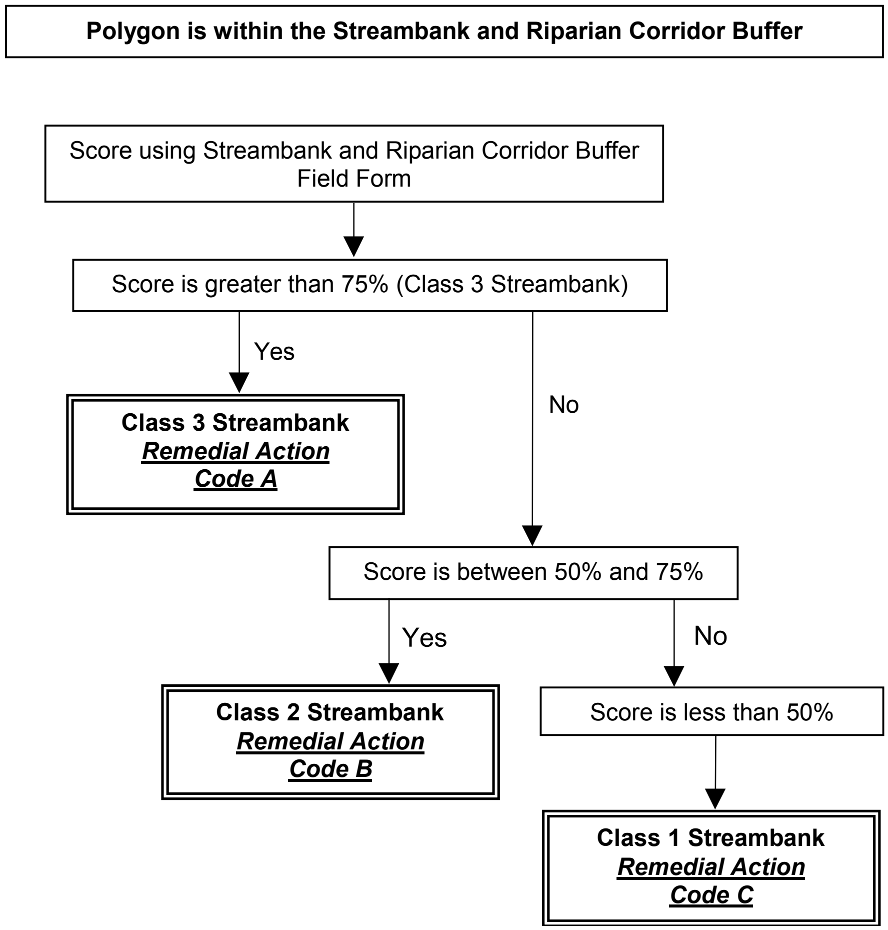

EXHIBIT 2-23
Preliminary Remedial Action (RA) Codes for Major CFR RipES Polygon Categories

CFR RipES Polygon Category	RA Code	Preliminary Remedial Action Recommendations[1]
Class 3 Streambank	A	Remedial actions include no action or minor actions to enhance vegetation within the buffer corridor and/or BMPs.
Class 2 Streambank	B	Polygons with Class 2 streambanks will receive remedial actions intended to secure streambank stability through establishment of appropriate deep, binding, woody vegetation. Remedial actions may include reconfiguration of the bank, minor removal/replacement and/or in-situ treatment of contaminated materials, followed by supplemental planting of deep, binding, woody vegetation and revegetation with appropriate herbaceous species and BMPs.
Class 1 Streambank	C	Class 1 streambanks will receive treatment(s) chosen from a set of remedial actions depending upon site-specific characteristics. Remedial actions for this class include removal of phytotoxic materials and revegetation with deep, binding, woody vegetation, and an understory of appropriate herbaceous species. BMPs.
Slickens (Exposed Tailings)	D	Remedial action for most of these areas is removal, with the exception as noted on page 2-95. Removal of slickens areas adjacent to active channel are part of the streambank remedial actions, BMPs, and ICs.
Impacted Soils and Vegetation Areas	E	Impacted soils and vegetation areas will generally be treated in-situ, with two exceptions: 1) when the tailings and contaminated soils in a given area extend more than 2 ft below ground surface (in which case, all of the material will be removed), and 2) when the tailings and contaminated soils are in a saturated condition which makes in-situ treatment impracticable (in which case, the contaminated material will be excavated). Old river channels in the floodplain will be addressed as described on page 2-96, along with BMPs and ICs.
Slightly Impacted Soils and Vegetation Areas	F	Remedial actions are no action, or BMPs.

[1]Data gaps need to be identified in order to define remedial action(s) and to satisfy initial remedial design specifications. These may include pH, concentrations of COCs in the soil profile, depth to permanent groundwater level, thickness of contaminated materials, acid-base account, organic matter level, and others.

3. Perennially or seasonally flooded wetlands that may contain contaminated sediment with hydrologic connectivity to groundwater and surface waters.
4. Contaminated areas that may be located within the historic floodplain, but outside the current FEMA defined floodplain. Some of these areas are separated from the main part of the floodplain by I-90, railroad berms, and other built structures.

These minor site types may contain much higher levels of contamination than adjacent areas because of particular historic circumstances. Removal, if feasible, will often be required. Therefore, these areas will be delineated as separate CFR RipES polygons, and evaluated accordingly for their potential need for remediation.

CFR RipES Process and Integration With Remedial Design. The CFR RipES process is to be applied to all lands within the historic 100-year floodplain of the Clark Fork River. The CFR

RipES process is a critical detail design component which, for a specific landowner, involves a series of steps beginning with delineation of land ownership boundaries and noting areas having similar ecological attributes on aerial photographs, and ends by delineating specific locations of slickens, impacted soils and vegetation, slightly impacted soils and vegetation and classification of Class 1, 2, and 3 streambanks. While at the property, additional design data and information will also be collected necessary to complete remedial design. It is envisioned that during remedial design, coordinated teams of ecologists and engineers will work together, with the ecologists scoring polygons and engineers surveying the polygons, and both working to produce GIS maps of the landscape, and collecting samples and other required design data and information for analyses. The general remedial design data gathering process is as follows:

1. Delineate existing land ownership boundaries, irrigation ditches, and fencelines on aerial photographs.
2. Delineate preliminary polygons on aerial photography for the following soil categories (minimum mapping unit size is 400 ft^2; and this must account for 100 percent of the property that lies within the historic 100-year floodplain):
   a. Slickens (exposed tailings)
   b. Impacted soils and vegetation areas
   c. Slightly impacted soils and vegetation areas
3. Delineate a preliminary streambank and riparian corridor buffer zone approximately 50 feet wide, on aerial photographs along both sides of the streambank. The buffer zone extends back approximately 50 feet from the bankfull stage on each side of the river. The actual width of the approximate 50-foot buffer zone is a function of the geomorphic characteristics of the river. For example, in those instances where the river abuts a high bank that is considered upland, the buffer zone width is reduced.
4. Conduct initial consultation with the landowner about present and future management desires (e.g., grazing pasture versus alfalfa field) and any potential modifications to remedial design such as location of temporary haul roads.
5. Obtain access from the landowners to conduct a CFR RipES evaluation of their property.
6. Conduct CFR RipES field reconnaissance, adjust preliminary polygon boundaries, and sample and collect data for scoring and classifying the following polygons:
   a. Soils polygons (slickens, impacted soils and vegetation areas, and slightly impacted soils and vegetation areas)
   b. Streambank polygons (Class 1, 2, and 3 streambanks)
7. Delineate the approximate 50-foot streambank and riparian corridor buffer zone into preliminary polygons based on live vegetative canopy cover and/or canopy cover of deep, binding, woody vegetation. There is a strong bias for leaving existing deep, binding, woody vegetation undisturbed. The minimum mapping unit of these polygons is 20 linear feet of streambank with a maximum length of 500 feet.
8. Delineate areas of deep, binding, woody vegetation outside the approximate 50-foot streambank and riparian corridor buffer zone. These represent areas where mature

woody vegetation may be obtained and utilized as tipped over willows in streambank treatment types 3 and 4 (these conceptual streambank treatment designs are summarized in item 10 of this list and described in Appendix B). There is a strong bias to leaving deep, binding, woody vegetation undisturbed.

9. Further subdivide (categorize) the streambank based on actively laterally cutting streambanks/critical shear stress areas. Assign a streambank treatment type to each subdivision. The minimum mapping unit length for this purpose is 10 linear feet of streambank. Data will be collected to determine the critical shear stresses associated with each streambank.

10. Conceptual streambank treatment designs were developed as examples for the upper Clark Fork River and are described in Appendix B. The conceptual treatments are as follows:

    a. No treatment necessary—This applies to streambanks where there is adequate deep, binding, woody vegetation already in place, and no additional work on the site is necessary.
    b. Treatment 1 (vegetation augmentation)—This treatment requires augmenting existing deep, binding, woody vegetation with additional woody vegetation.
    c. Treatment 2—This treatment is for streambanks where low critical shear stresses are acting on the immediate streambank. This treatment involves the use of pre-vegetated coir roll-sod with a toe protection of fiber-rolls pre-vegetated with sandbar willow (*Salix exigua*).
    d. Treatment 3—This treatment is for streambanks where moderate critical shear stresses are acting on the immediate streambank. This treatment involves the use of pre-vegetated coir roll-sod with a toe protection of fiber-rolls pre-vegetated with sandbar willow (*Salix exigua*) on top of a rock roll. Also included is tipped over mature willow on a spacing that will depend on river morphology along the streambank to deflect and dissipate the energy of the stream.
    e. Treatment 4—This treatment is for streambanks where high critical shear stresses are acting on the immediate streambank. This treatment involves the use of pre-vegetated coir roll-sod with a toe protection of rock mattress. Also included is tipped over mature willow on a spacing that will depend on river morphology along the streambank to deflect and dissipate the energy of the stream.

    Other site-specific conditions may dictate design modifications.

11. Identify data needs to be filled to define remedial action(s) and to satisfy initial remedial design specifications. These may include pH, concentrations of COCs in the soil profile, depth to permanent groundwater level, thickness of contaminated materials, acid-base account, soil organic matter level, and others identified. Sampling will be conducted on the polygons to fulfill these gaps using a Sampling and Analysis Plan developed for the OU. The intent is to sequence the CFR RipES scoring and sampling concurrently so that data are collected in an efficient manner and landowner disturbance is minimized.

12. Develop a preliminary design for the property. Components of preliminary design include the following:

    - Base map with layer displaying 1-foot contours

- Location of CFR RipES-defined polygons for streambanks, slickens, impacted soils, and vegetation areas
- Transportation corridors and existing roads
- Locations of temporary fences
- Locations of potential staging areas
- Locations of wetlands and irrigation and drainage ditches
- Locations of water access points for livestock
- Locations of temporary bridges
- Locations of vegetation that is to be removed during clearing and grubbing, and locations of salvageable vegetation that can be used during remediation
- Other appropriate data and information

13. Present preliminary remedial design and preliminary construction schedule for the property to the landowner, including weed management plan, preliminary grazing management plan, BMPs, and ICs. Obtain landowner feedback.
14. Prepare revised design and construction schedule based on landowner feedback.
15. Submit to appropriate agencies for review. Obtain agencies' approval, and then obtain landowner access for implementation.

13.6.2 Removal of Exposed Tailings

Specific areas of exposed tailings or slickens areas, as defined previously (determined by CFR RipES to be slickens areas resulting from phytotoxicity), and contaminated soils beneath these areas, within the entire floodplain, will be removed to the required depths determined by CFR RipES sampling and analysis. Removal utilizes the excavation of severely impacted soils with low pH and generally higher metals and arsenic concentrations, followed by replacement with appropriate soils that can then be successfully revegetated.

Typical types of excavation equipment, such as backhoes, hydraulic excavators, bulldozers, front-end loaders, and 10 to 12 cubic yard dump trucks, will likely be used for this task. In some locations, it may be possible to utilize scrapers or larger capacity off-road haul trucks effectively, depending upon specific circumstances. Within the near-river channel riparian corridor, removal will be conducted with the appropriate smaller sized equipment to avoid disruption of existing streambank stability, including the streambank toes and existing woody vegetation with valuable deep binding root mass. Live deep binding woody vegetation would not be disturbed. Soils can be removed at higher excavation rates in areas away from the river; whereas along or near the streambank, excavation must be slower and more precise so as not to damage the stability of the riverbank or existing woody vegetation.

Post removal confirmation sampling will be required to verify that a sufficient depth of soils have been removed prior to starting backfill operations. Visual examination for tailings material, as well as discrete soil sampling at predetermined locations and depth intervals, are initially suggested. Further details will be determined during remedial design.

To accommodate the use of different types of equipment at various slickens locations, temporary haul roads must be built to provide access points to and from existing public roads. In addition, the use of temporary bridges or other special equipment may be necessary to move materials across the river, if no access to public roads is available (generally a problem on the west side of the river south of Deer Lodge). Once on public roads, the excavated slickens materials will be transported and placed into the Opportunity Ponds Waste Management Area Repository. Closure of this area is a responsibility under Anaconda Regional Water and Waste Soils Operable Unit (ARWWSOU) remediation. Depending upon location, portions of certain public roads may need to be upgraded to carry the required loads and to ensure safe conditions. Construction BMPs, such as watering haul roads, wetting temporary stockpiles of excavated materials, use of covered haul trucks to minimize fugitive dust emissions, use of traffic safety haulage plans, and the use of silt fences and runoff straw bales, will be mandated and utilized during removal, backfilling, or when other disturbances occur on site. The U.S. Fish and Wildlife Service (FWS) Biological Opinion and continued consultation with the FWS may mandate additional BMP measures.

After removal, and as appropriate depending on the land use (to be determined during design), an equivalent volume of clean soil backfill will be brought to the site and placed in the excavations, leveled, and compacted for revegetation. Backfill material will be selected based on considerations of in-situ compacted density, and will be tested to determine its suitability as a growth media for both riparian and herbaceous vegetation. Consideration will be given to reducing backfill needs, where possible. Borrow material source areas must be carefully planned to minimize amount of disturbed land, and must be adequately reclaimed. The backfill soils must meet the criteria listed below (see also Section 13.8.2.1, page 2-113):

- Match strict chemical and physical specifications (e.g., soil type, grain size, metal and arsenic concentrations, percent organic, etc.)
- Be free of weeds and weed seeds
- Contain the required quantity of organic materials and other nutrients necessary for growth media

Wetlands, ponds, and marshes are also common along the floodplain. Despite the contamination that usually resides within the underlying soils of these wetlands areas, they are generally biologically robust. The Selected Remedy seeks to enhance areas near existing wetlands, ponds, and marshes, and to create new wetlands where there are willing landowners and where ideal opportunities for new wetlands present themselves during remedy implementation. Such areas must be sufficiently distant from the active channel so as not to contribute to the floodplain’s susceptibility to destabilization during remedy implementation. Old channels and oxbows that are filled with tailings and impacted soils from previous floods will be addressed through the CFR RipES process (as described in Section 13.3, page 2-85). Such features, after removal of contaminated materials without backfill, would rapidly fill from high groundwater and become healthy wetlands, ponds, and marshes.

13.6.3 Treatment of Impacted Soils and Vegetation Areas

As an initial step in remedial design, CFR RipES will be utilized to locate and map all areas within the OU on the landowner's property containing impacted soils and vegetation communities, including specific additional information on the affected soils, at various depths. Areas containing slightly impacted soils vegetation communities will be located and mapped as well. Areas defined to contain impacted soils and vegetation will be remediated using in-situ treatment, with the exceptions described previously. Areas containing slightly impacted soils and vegetation will not require any active remediation.

In-situ treatment utilizes the incorporation and intimate mixing of chemical amendments into moderately impacted soils (prior to treatment, the soils typically exhibit low pH values). The treatment is designated to raise the pH, attenuate and dilute metals and arsenic, and allow these soils to be successfully revegetated.

The use of in-situ treatment techniques first requires the determination of the acid generation potential of the soils and the depths to which the soils are impacted. Numerous soil samples will be collected to appropriate depths during the CFR RipES investigations. The samples will be composited appropriately and analyzed for pH, acid base account, specific metal and arsenic concentrations, soil organic content, and other factors. This data will be reviewed and evaluated as part of the remedial design process.

Prior to the addition of chemical amendments, the areas to be treated are typically cleared and grubbed of dead woody vegetation to facilitate the spreading and incorporation of lime. The chemical amendment typically consists of a mixture of minus 60 mesh agricultural grade limestone ($CaCO_3$) and calcium oxide (CaO), applied in sufficient quantities to the grubbed areas to exceed the acid generating capacity of the existing impacted soil. Techniques for adding the lime amendment involve the use of typical agricultural lime spreaders where the rate of application can be varied to the needs of the soil. Where access to areas may be limited, placement may be done by smaller equipment such as a small front end loader or even by manual application. Lime is applied and then incorporated by deep plow, agricultural tiller, or special mixers, depending upon depth. A number of passes with the plow, tiller, or mixer are typically needed to assure complete mixing with the soil. Agricultural tillage up to depths approaching 12 inches can be completed with a disc, chisel, or moldboard plow. For deeper tilling, incorporation and mixing of lime and soil has been successfully completed to depths up to 30 inches with the use of a Baker disc type plow being pulled by a large tractor or bulldozer, again using several right or acute angle passes. Other large or small rotary-type mixers have also been used to very effectively mix and incorporate amendments in dry conditions. These application techniques can be utilized in areas with shallow groundwater, if the area is not too wet to permit equipment access, and if the mixer blends amendments without the formation of unmixed "balled-up" materials.

13.6.4 Streambank Stabilization, and Re-Vegetation of the Riparian Corridor and Historic 100-Year Floodplain

This component of the *Selected Remedy* is intended to significantly reduce streambank erosion from each impacted property along Reach A and isolated portions of Reach B of the Clark Fork River OU, and to re-establish both a protective riparian vegetative corridor as well as healthy herbaceous vegetation in the remainder of the historic 100-year floodplain.

This component of the Selected Remedy, when implemented, should significantly improve surface water quality over the long term.

The design condition should represent the most adverse condition likely to occur on the stream, but this is not typically the largest flood. Generally, some intermediate discharge in the 2- to 10-year return frequency exerts the greatest force against the channel boundary and is selected as the design discharge (Fischenich 2003). All streambank stabilization treatments will be designed to withstand a 10-year return flow flood event from the time of installation without the benefit of expected future plant growth. Selection of these criteria is based on the following assumptions:

1. Planting prescriptions are correct to achieve the stated objectives.
2. All coir and other materials employed in streambank stabilization treatments will have an effective lifespan of 10 years.
3. All plantings, including those in pre-vegetated coir products, will achieve growth within 10 years sufficient to take over the task of holding the streambank together from the coir (i.e., hold the streambank from eroding) without further dependence on the coir matrix. In other words, *Salix exigua* (sandbar willow) will have achieved approximately 75 percent or more of its potential growth form in 10 years and all other woody plants will have achieved between 50 to 75 percent of their potential growth form during this same timeframe.
4. Initial plants have sufficient water to achieve maximum growth. In other words, water is not a limiting factor.

Appendix B contains a detailed description of the Clark Fork River hydrology and design considerations as they apply to the Selected Remedy. This appendix also contains examples and illustrations of streambank stabilization applications that will be used in the Selected Remedy.

13.6.5 Access and BMP Enforcement

The Clark Fork River OU remedial action may be implemented by PRPs under EPA order or judicial decree, or it may be implemented by the agencies. EPA orders and decrees require PRPs to pay reasonable compensation to landowners or tenants for access. The loss of production from the land affected by implementation of the remedial actions, including remedial components such as road building and staging areas, will be an important issue that must be addressed in any access agreement.

BMPs are an important part of the remedy and are discussed in detail in Section 13.9.1, page 2-120. BMP implementation and other maintenance and monitoring functions such as fence maintenance will also be important issues to address when BMP agreements are developed. Lost land use and reasonable compensation will be important components of these discussions.

EPA will work cooperatively with landowners and tenants as the implementers of the remedial action seek access and long term BMP agreements. EPA will insist on fair and reasonable compensation for remedial activities that affect productive land use.

BMP implementation and enforcement will require additional post-ROD discussion among interested parties. Clearly defined BMPs and the ability to ensure that BMPs are implemented is very important to the success of the remedy. As noted in Section 13.9.1, page 2-120, EPA will work with the PRP, other stakeholders, and the Department of Agriculture to develop an effective, funded, and enforceable BMP program.

13.7 National Park Service: Grant-Kohrs Ranch National Historic Site

As discussed in Section 5.2.2.1, page 2-20, the Grant-Kohrs Ranch National Historic Site (Grant-Kohrs), a unit of the National Park System administered by NPS, lies within Reach A of the Clark Fork River OU. EPA and NPS have identified location-specific ARARs with respect to hazardous substance releases within or potentially affecting Grant-Kohrs. These location-specific ARARs are derived from the NPS Organic Act, 16 U.S.C. §§ I et seq. (the Organic Act), and the enabling legislation for Grant-Kohrs Ranch (Pub L. 92-406, 86 Stat 7632 [1972]; Grant-Kohrs Act). As described further in Part 3, *Responsiveness Summary*, and within this section of the *Record of Decision*, attainment of these ARARs requires remedial measures that ensure the historic ranch landscape of the late nineteenth century is reestablished, preserved, and sustained for future generations in a condition unimpaired by hazardous substances.

Specifically, the Grant-Kohrs Act, read in combination with the Organic Act, establishes location-specific requirements for the Grant-Kohrs Ranch National Historic Site; the attainment of which is necessary to enable this national historic site to fulfill the statutory purposes for which it was established. These location-specific ARARs translate into defined performance standards for the remedial action to attain. These performance standards require that the selected remedial action re-establish self-producing and sustaining native riparian vegetative communities and species that are required by the ARAR standard.

The NPS has undertaken extensive research to define specifically the native riparian vegetative species that should be used as indicators to determine whether these performance standards are attained. This research indicates that 17 different plant communities should be found within the riparian zone of the Grant-Kohrs Ranch National Historic Site (see Exhibit 2-24). The number of species ranges from 5 to 35 depending on the community. (For the detailed species list from which each community will be formed, and the minimum number of species that will be required in each community, see Appendix E.) These baseline plant communities would be present today, if the past and ongoing releases of hazardous substances from upstream mining activities had not occurred. Each plant community has been defined in terms of the composition of native plant species that would be expected within each community and the relative abundance of each species.

To attain site-specific ARARs for the Grant-Kohrs Ranch National Historic Site, the CFR RipES system will be applied as described in Section 13.6.1.1, page 2-92. Polygon delineation will identify areas that fall within one of the six major categories of sites defined by CFR RipES. Slickens areas will be excavated and removed in the same manner as other slickens areas within the Clark Fork River OU. Areas within the approximate 50-foot streambank buffer zone from which tailings and contaminated soils are excavated will be backfilled to

EXHIBIT 2-24
Plant Community Baseline List for the Grant-Kohrs Ranch National Historic Site

Habitat Type (HT) or Community Type (CT) Name	Deer Lodge Valley Distribution Category[1]	Estimated Percentage of Grant-Kohrs Remediated Area	Floodplain Position Where the Type Is Located
Tree Dominated Types			
Black Cottonwood/Red-osier Dogwood (*Populus trichocarpa/ Cornus stolonifera*) CT	Minor	8-12	Recent point bars and low floodplain terraces
Quaking Aspen/Bluejoint Reedgrass (*Populus tremuloides/Calamagrostis canadensis*) HT	Incidental	<1	Slightly moist to mesic floodplain sites
Shrub Dominated Types			
Geyer Willow/Bluejoint Reedgrass (*Salix geyeriana/Calamagrostis canadensis*) HT	Major	18-23	Drier areas in old oxbows, floodplain terraces
Water Birch (*Betula occidentalis*) CT	Major	12-18	Moist areas, old oxbow banks, streambanks
Geyer Willow/Beaked Sedge (*Salix geyeriana/Carex rostrata*) HT	Major	12-18	Moist areas, old oxbow, streambanks
Sandbar Willow (*Salix exigua*) CT	Minor	8-12	Recent point bars, streambanks
Woods Rose (*Rosa woodsii*) CT	Minor	1-3	Drier areas on upper floodplain terraces
Western Snowberry (*Symphoricarpos occidentalis*) CT	Minor	1-3	Drier areas on upper floodplain terraces
Mountain Alder (*Alnus incana*) CT	Minor	1-3	Moist areas, old oxbow banks, streambanks
Graminoid Dominated Types			
Beaked Sedge (*Carex rostrata*) HT	Minor	5-8	Wet sites, old oxbow, or slough bottoms
Bluejoint Reedgrass (*Calamagrostis canadensis*) HT	Minor	3-6	Moist areas, old oxbow, and streambanks
Western Wheatgrass (*Agropyron smithii*) HT	Minor	3-6	Drier open areas away from the river channel
Water Sedge (*Carex aquatilis*) HT	Minor	2-4	Wet sites, old oxbow, or slough bottoms
Common Spikesedge (*Eleocharis palustris*) HT	Incidental	<1	Ponded areas, water edges
Forb Dominated Types			
Common Cattail (*Typha latifolia*) HT	Minor	2-4	Ponded areas, old oxbow, and slough bottoms

[1]A *major type* occupies extensive acreages in at least some portion of the riparian or wetland zone; a *minor type* seldom occupies large acreages but may be common on smaller areas within the riparian or wetland zone; and an *incidental type* rarely occurs within the region, or is limited to narrow site conditions and/or very localized occurrence.

the pre-remedy elevations where necessary for streambank stability. Areas outside the 50-foot streambank buffer zone may be backfilled or not, based on NPS preference. Backfilling with uncontaminated soils appropriate to floodplain conditions, as defined in Section 13.8.2, page 2-113, will occur along streambanks where needed for bank stability after removal of phytotoxic material.

Impacted soils and vegetation areas identified using CFR RipES will generally be treated in-situ. During remedial design, EPA and the NPS will carefully evaluate site-specific conditions to confirm the efficacy of in-situ treatment as a means to attain NPS ARARs. If EPA and the NPS determine that in-situ treatment is not suitable to attain such ARARs, excavation and removal will be considered and implemented as appropriate to attain ARARs.

Impacted soils and vegetation areas that receive in-situ treatment will be monitored using defined performance standards, described in Section 13.11, page 2-126, and additional criteria developed jointly by EPA and NPS during remedial design. Monitoring will continue beyond the irrigation period to determine survival rates under natural hydrologic conditions. In consultation with NPS, a 10-year vegetation monitoring plan will be developed during the remedial design phase. The 10-year period is appropriate because of the arid nature of the Deer Lodge Valley climate, the likelihood of extreme weather events within that timeframe, and to account for the slower growth rate of the desired woody species. This plan will include plant species composition, distribution, density, and other parameters appropriate in evaluating the degree to which the desired plant communities have been successfully reestablished.

Failure to meet performance criteria, as determined jointly by EPA and NPS, will result in revegetation efforts appropriate to the desired plant community in a given polygon. Replanting of decadent or unhealthy vegetation in the same polygon will be limited to three replanting attempts, after which excavation and removal will be implemented. Excavation and removal under these circumstances will be performed in the same manner as for slickens areas. With the concurrence of EPA and NPS, excavation and removal may be triggered without attempting the maximum number of replanting attempts, but only after a thorough review of monitoring data.

Areas of relatively healthy, mature woody vegetation cover (willows, alder, water birch, and cottonwood) will be left undisturbed. These areas constitute approximately 53 acres of the fenced riparian area within the Grant-Kohrs Ranch National Historic Site. This determination to leave such undisturbed areas is based on the premise that such areas will have a greater benefit if left in place because of the geomorphic stability provided by extant root systems. This does not mean, however, that such areas are unimpaired or uninjured. On the contrary, these areas, too, deviate from the baseline plant communities native to the Grant-Kohrs Ranch National Historic Site. Nevertheless, EPA and NPS have determined that, on balance, RAOs will be best achieved if such areas are left undisturbed.

Streambank stabilization within the Grant-Kohrs Ranch National Historic Site will be required along a minimum of 9,450 feet of concave “cutbanks” using soft technologies, as described in Section 13.6.4, page 2-106. A possible exception to the use of such soft technologies is the river bridge where channel migration threatens both the road and bridge. In that area, EPA and NPS may determine that it is necessary to utilize more rigid bank protection measures. To the extent possible, however, stabilization of those banks will be achieved in a manner that appears natural and as well vegetated as is technically feasible. Existing bare rip-rap will be removed to the extent possible. Additional rip-rap or visible gabion baskets will not be utilized. In addition, irrigation ditch risk and possible remedial action shall be addressed in accordance with the criteria established in Section 13.8.3, page 2-119.

13.8 Additional Selected Remedy Considerations

Some additional considerations for the Selected Remedy, including caring for existing vegetation, steps in the revegetation process, and measures for wetlands, ponds, marshes, and irrigation ditches, are described in this section.

13.8.1 Existing Vegetation

On sites that will receive remedial treatment by removal of contaminated soil or of in-situ mixing and amendment of less contaminated soil, some woody plants will be affected. The desired option is to leave as many as possible of certain "preferred woody plant species" in place that are already growing on the floodplain within the Clark Fork River OU. This will be accomplished by working around them whenever practicable and whenever the overall goals of the project can still be achieved by doing so.

The set to be considered "preferred woody species" includes the following plants:

- All willow species (*Salix* spp.)
- Water birch (*Betula occidentalis*)
- Red-osier dogwood (*Cornus stolonifera*)
- Common chokecherry (*Prunus virginiana*)
- Western serviceberry (*Amelanchier alnifolia*)
- Mountain alder (*Alnus incana*)
- Cottonwood (*Populus trichocarpa)*

Because these plants occur on all kinds of sites and distribution patterns, a systematic protocol is needed for deciding when to remove and when to keep a particular plant. The key in Exhibit 2-25 provides a systematic procedure for deciding this issue on the basis of location and condition of plants.

There is a strong desire to leave existing woody vegetation undisturbed and to improve poorly vegetated streambank areas because of its importance in preventing erosion, channel migration, and floodplain destabilization. All construction activities will utilize construction BMPs to protect healthy vegetation and the river. All remediated lands will be protected to allow adequate establishment and growth of new vegetation. Once this regrowth time has occurred, the land will be brought back into the normal land use activities as outlined by each landowner. The land will be monitored to ensure adequate growth and establishment of the vegetation, especially the woody vegetation along the streambank.

Weed control will be a critical element of remediation. An aggressive integrated weed management program will be implemented during the construction cycle. Any time soil is disturbed, weeds will try to invade; therefore, an herbaceous mixture of grasses and forbs will be seeded into all treatment areas. All sites will be monitored and treated for 5 years for weed infestations as part of the post-construction monitoring process. Weed control is addressed in depth in Section 13.10, page 2-123.

EXHIBIT 2-25
Key for Deciding Whether to Remove or to Keep a Plant

***Instructions*:** Read both parts of each couplet pair carefully before deciding which part is the better answer. Decide which side of the couplet pair is most nearly true (this will require best professional judgement in each case), and proceed to the next couplet indicated, until you arrive at an answer to remove or keep.

1. The plant is near the streambank (within 10 ft, approximately one mature shrub width) **2**
   2. Contaminated soils contiguous to the plant are being removed, AND visibly contaminated soil extends into the main root mass of the plant, AND bank stabilization Treatment 2, Treatment 3, or Treatment 4 is being implemented at this point along the bank................................. **REMOVE**
   2. Contaminated soils contiguous to the plant are not being removed, OR visibly contaminated soil does not extend into the main root mass of the plant, OR bank stabilization Treatment 2, Treatment 3, or Treatment 4 is not necessary at this point along the bank .... **KEEP**
1. The plant is not within 10 ft of the streambank **3**
3. The plant is more than 10 ft from the streambank, but is within the Streambank Riparian Buffer Zone) **4**
   4. The area that includes the plant is a slickens (Contaminated soil will be removed) **5**
5. The plant is isolated (10 ft or farther from other plants of preferred woody species) **6**
   6. The plant is of seedling/sapling age class OR is decadent (has more than 30 percent dead wood in its upper canopy).. **REMOVE**
   6. The plant is of mature age class AND is not decadent (Does not have more than 30 percent dead wood in its upper canopy).. **KEEP**
5. The plant is not isolated (It is closer than 10 ft to other plants of preferred woody species; i.e., a subpolygon can be drawn around a group of preferred woody plants, including this one, to keep undisturbed within the slickens area of contaminated soil being removed.) .... **KEEP**
   4. The area that includes the plant is to have impacted soils treated in-situ.................................... **7**
7. The plant is isolated (10 ft or farther from other plants of preferred woody species) **8**
   8. The plant is of seedling/sapling age class OR is decadent (has more than 30 percent dead wood in its upper canopy).. **REMOVE**
   8. The plant is of mature age class AND is not decadent (does not have more than 30 percent dead wood in its upper canopy).. **KEEP**
7. The plant is not isolated (it is closer than 10 ft to other plants of preferred woody species; i.e., a subpolygon can be drawn around a group of preferred woody plants, including this one, to keep undisturbed within the slickens area of contaminated soil being removed.)................................ **KEEP**
3. The plant is outside the Streambank Riparian Buffer Zone **9**
   9. The plant is isolated (is 10 ft or farther from other plants of preferred woody species) .. **REMOVE**
   9. The plant is not isolated (it is closer than 10 ft to other plants of preferred woody species; i.e., a subpolygon can be drawn around a group of preferred woody plants, including this one, to keep undisturbed within the slickens area of contaminated soil being removed.)......................... **KEEP**

In general, slickens areas are nearly devoid of vegetation, and part of the CFR RipES definition of a slickens area or barren tailings is less than 25 percent vegetation cover of live plants. Another part of the CFR RipES characterization is that tufted hair grass is almost always present along the margins of the slickens and/or sometimes within the slickens (tufted hair grass is tolerant of lower pH and metals, and is therefore used as an indicator of such conditions). These plants will be removed along with the slickens as part of construction activities. Larger plant species such as willow clumps and water birch can be left in place, especially if they are adjacent to or surrounded by slickens, if they are robust, and if they provide deep binding root mass. They also provide browse for cattle and wildlife, structural diversity in the herbaceous vegetation community that will be established, and wildlife habitat. Appropriate care, through construction BMPs, will be exercised to identify existing vegetation that can be sacrificed and vegetation that is not to be disturbed. Existing vegetation in areas categorized with moderately dysfunctional plant communities may have significant vegetation that is to be retained during in-situ treatment. Landowner-specific remedial designs will address existing vegetation within and adjacent to barren slickens.

13.8.2 Revegetation Processes

Successful reclamation of land contaminated by mining activities within the Clark Fork River OU is defined as the establishment of plant communities capable of stabilizing contaminated soils against wind and water erosion, reducing COCs transport to groundwater, reducing the risk to human health and the environment, and compliance with Performance Standards, in perpetuity.

For the alternatives to meet the objectives, the physiochemical characteristics of soils media must meet minimal specifications to allow establishment of vegetation. Design criteria must be specifically linked to the physical characteristics of a particular area or polygon targeted for revegetation, along with its current and reasonably anticipated land use (which in most areas will be agriculture). Given the size of the potential remedial units, each parcel of land or polygon will be evaluated for a specific standard that is linked to land use, depth and level of soil contamination, and the physical conditions of the site. Furthermore, the physical conditions and landscape position of the site will influence the percent cover that can be maintained. Design criteria may include, but are not limited to, parameters set forth for depth of rooting media, texture, pH, metal concentration, organic matter, specific conductance, surface manipulation, and appropriate seed mixture.

13.8.2.1 Cover Soil for Excavated Areas

Cover soil design specifications for use as replacement soil after excavation of slickens and other areas are required to meet the following specifications:

- **Depth:** The entire depth of contamination is to be removed from slickens areas. In some areas, sufficient cover soil will be placed to bring area to pre-removal grade. In other areas, cover soil may not be used. When cover soil is used, the goal is to achieve a hospitable rootzone of at least 18 inches of non-toxic rooting media, except for residential yards. This is the absolute minimum for the long-term success of the vegetation. Enough cover soil needs to be applied to account for settling, sloughing, and erosion.

- **Coarse fragment contents:** Particles greater than 0.079 inches (2 millimeters) will constitute less than 45 percent (by volume) of the cover soil. Maximum rock size is 6 inches (15 centimeters) in diameter.

- **Texture:** Sandy loam or finer (to have the proper water holding capacity). Clay soils are not acceptable.

- **pH:** Between 6.5 and 8.5 for entire depth of cover soil.
- **Metal concentration:** Cover soil guidelines: arsenic < 30 ppm, cadmium < 4 ppm, copper < 100 ppm, lead < 100 ppm, and zinc < 250 ppm.
- **Organic matter:** Cover soil or engineered media having >1.5 percent (by weight) of composted organic matter in the upper 6 inches for upland areas. Cover soil imported into riparian areas must have organic matter levels of approximately 5 to 7 percent or similar to adjacent areas that are not contaminated and will not be remediated.
- **Specific conductance:** Cover soil or engineered rooting media must be less than 4.0 deciSiemens per meter for entire depth of cover soil.

13.8.2.2 Criteria for In-Place Treated Areas

Key components for successful implementation of in-situ reclamation are as follows:

- **Neutralizing amendments and pH control**: Only lime materials approved for use by the lead agency will be used for in-situ treatment. The field lime rate is based on acid base chemistry, the appropriate equation, and adjustments for calcium carbonate equivalence, particle size, and moisture. The pH of the growth media for treatment actions must be greater than 6.5 and less than 8.5, or equal to or greater than 7.0 and less than 8.5 if neutralizing amendments are used in the implementation of the action. The acid/base account of the treated growth media must be greater than zero.
- **Soil arsenic concentration:** For any remedial action taken at a specific location, the final growth media, either the cover soil or treated soil, is to meet the human risk based arsenic concentrations for the current land use and reasonably anticipated land uses.
- **Depth of amendment incorporation:** The general approach is to treat the entire depth of contamination at a specific location with neutralizing amendments. Tillage should be deep enough to incorporate beneficial materials (e.g., organics, clean soil) where practicable.
- **Organic matter:** The organic matter content within the treated rootzone in riparian areas must be equivalent to organic matter in adjacent, non-contaminated riparian soils. For upland areas, the organic matter in the top 6 inches of the treated growth media must be 1.5 percent.
- **Vegetation selection**: Native vegetation—including grasses, shrubs, and trees—will be specified for many areas that will receive remedial actions. For other areas, the vegetation community to be established will depend on current and future land uses and consideration of landowner preferences. Remediated areas that are to be used for intense agricultural production—for example, irrigated alfalfa—will be seeded with appropriate agronomic species. Vegetation performance will be integrated into specific remedial designs based primarily on end land use.

13.8.2.3 Best Reclamation Practices

Best reclamation practices are to be implemented during the implementation of the Selected Remedy. Some of these are identified below:

- **Site preparation:** Prior to implementation of the design for specific location or polygon, certain amounts of preparatory work will commonly be required. Preparatory work may include, but is not limited to, access roads, grading, clearing, grubbing, marking, development of staging areas, debris removal, amendment stockpiling, and stormwater control feature installation. The timing of site preparation tasks should be specified in design documents.

- **Temporary stormwater BMPs:** Control of sediment caused by remedial construction is required where surface water and wetlands are present adjacent to remediation areas, or where ditches and overland flow may convey stormwater from remediation areas to surface waters. BMPs for stormwater control are to be implemented.

- **Grading:** Regrading of rough surfaces should be considered in advance of tillage where erosional rills and gullies are sufficiently deep and pervasive that they limit amendment application, tillage, and related components of the remedial action. Site grading should be considered in concert with clearing and grubbing.

- **Clear and grub:** Removal of unwanted debris (refuse) and vegetation is to be part of the remedial design. Good judgment is imperative in selecting existing vegetation that should be preserved and vegetation that limits implementability and/or treatment effectiveness. Preference is given to preserving deep, binding woody vegetation, which consists of species that are important to the post-remedial land use and to large stems that could only be established over a great length of time.

- **Preservation of Existing Vegetation:** Preservation of desirable existing vegetation is an important consideration for areas to be excavated, treated in place, and within the riparian buffer zone. See Section 13.8.1, page 2-111, for additional detail.

- **Cover soil application:** After excavation of contaminated tailings/soils, cover soil is to be imported that meets specific chemical and physical specifications. For additional detail, see Section 13.8.2.1, page 2-113. Normal engineering practices are to be implemented to apply, grade, etc. These are to be specified in the remedial design(s).

- **Amendment selection, application and mixing:** Lime products include the family of neutralizing solids that may be applied to contaminated soils and include calcium carbonate ($CaCO_3$), calcium oxide (CaO) and calcium hydroxide ($Ca(OH)_2$). Reagent grade materials (99 percent purity or greater), ground to less than 200 mesh and with less than 1 percent water content, are preferred. Lime sources with lower levels of purity, coarser particle size, and elevated water content may be acceptable for use with EPA approval. Organic amendments include composted manure, manufactured compost, and other products. The use of organic materials that have not been composted, such as wood chips, sawdust, or fresh manure, are not considered sufficiently beneficial for plant growth in the short term and are not applicable for use in the Clark Fork River OU. Other amendments, such as phosphorus to minimize arsenic mobility, may be considered as part of the remedial design.

  Surficial application of amendments may be accomplished by a variety of equipment. Measurement of the amendment rate is required for calibration of the spreading equipment and for documentation of the rate of application for post-construction reporting. Seeding immediately following tillage will generally not be possible because of chemical and physical limitations. Lime addition and tillage tend to dry and loosen the soil making seeding physically difficult. The treated soil will typically require some period of "mellowing" to ensure that unacceptably high pH conditions (greater than pH 8.5) no longer persist following lime addition. The mellowing period may be as short as hours or as long as months depending on the geochemistry of the soil.

- **Seedbed preparation:** To facilitate seeding and improve the probability of seeding success, seedbed preparation is necessary. This includes leveling, breaking up of large clods, and reduction of soil seedbank and competitive plants. Appropriate equipment is employed to produce a good seedbed.
- **Fertilization:** Addition of nitrogen, phosphorous, and potassium fertilizer to treated and cover soils is required. Fertilization application should be performed prior to tillage such that phosphorous and potassium fertilizer are incorporated into the soil. Fertilizer should be tilled into the top 4 to 6 inches of the soil. Application of fertilizer can be accomplished by various approaches, including mechanized and hand powered spreaders. A standard fertilizer rate is not acceptable across the entire Clark Fork River OU. Research has shown (RRU 1993) that plant growth in highly contaminated soil is dependent on high phosphorus application rates, especially in soils with high levels of soluble arsenic.
- **Seeding:** Seeding of vegetation without supplemental irrigation should be performed either in the spring in advance of wet June weather, or in the fall after the growing season. Seeding may be performed by two principal methods: drill or broadcast seeding. Calibration and confirmation of seed application rates can be performed similarly to amendment application rate confirmation by placement of a tarp of known area on the ground and subsequently weighing or counting the number of seeds applied following seeding of the area. Weed free seed will be used with known germination rates. The seed source and quality should be reported in post construction documentation. Seed bag tags should be collected to provide documentation of the seeded species in parallel with the seed rate. Herbaceous communities are to be established that meet landowner management perspectives, which may include forage for cattle, agronomic crops, and others. Native plants that provide species and structural diversity will be emphasized for areas of wildlife use.
- **Planting:** In the riparian buffer zone, willow seedlings planted near the edge of the river and tipped-over willows are the first structures planted to stabilize banks. Bagged willows and mature willow transplants plus other woody species are also to be planted within the corridor. Remedial designs will specify numbers and species.
  - Disturbance of the streambank toe should be avoided or minimized. Care must be exercised to avoid destabilizing the outer streambank when removing or remediating in place. Removal of the toe of a streambank must be avoided. Unnecessary removal of a toe of the streambank will destabilize the entire streambank and result in accelerated erosion. Care should be taken during removal or in-situ treatment of phytotoxic soils to minimize any activity that may reduce the current streambank stability.

- To preserve geomorphic stability, the bank should be reconstructed to match its existing elevation, with as normal a streambank profile as possible. Removed materials will be replaced with suitable growth media-type soils meeting specific chemical and physical requirements.
- Once phytotoxic soils have been either removed and replaced with suitable soils or treated in-situ, appropriate revegetation of this streambank riparian buffer corridor or zone can be accomplished. All transplanting holes should be as small as possible to reduce fracturing of the streambank. This can be accomplished using an auger or other hole-producing equipment, instead of a backhoe, whenever possible.
- *Salix exigua* (sandbar willow) is to be the major plant used in the revegetation process. *Salix exigua* (sandbar willow) is a pioneer species that populates gravel bars and other riparian sites. The plant has adapted to high spring flows by flowering and setting its leaves on the falling limb of the hydrograph curve (i.e., immediately after high flow). This prevents the plant from having its leaves removed by high flow, and allows it to produce seed that can land on fresh, new sediment deposits. In addition, the plant has adapted to both ice flows and beaver activity. The plant is different from other native willows in the valley in that it is rhizomatous. Therefore, it does not form a clump of multiple stems from one set of roots, and it can rapidly invade a site from a single plant. *Salix exigua* (sandbar willow) also has a rapid growth rate of between 4 to 6 feet per year under optimal conditions. Currently, *Salix exigua* (sandbar willow) is the dominant willow along the Upper Clark Fork River, and is what one would expect to find along a river of this size in western North America. Therefore, the use of the plant in revegetation of the upper Clark Fork River would support the concept of developing a self-maintaining natural system.
- The key to any transplanting is to have the plant in contact with either the lowest water table encountered in a year or the capillary fringe at base flow. This can be accomplished by using an auger or other equipment attached to a tractor to drill a hole quickly and plant the material to the required depth. If this can not be done, then supplemental water is needed.
- Small containerized plants are generally more effective than willow stakes. Results from the use of willow stakes tend to show a success rate of around 20 to 30 percent after year 2. During the first year, a flush of new growth and a high rate of success seems possible (50 to 70 percent). However, after one winter season, only a small percentage of the plants grow the following year. Therefore, it is necessary to look at the success rate in the second growing season and not the initial growing season. This success rate has also been verified by Chris Hoag of the National Resources Conservation Service (NRCS) in Idaho, Eric Reiland of MFWP in the Clark Fork River watershed, and others throughout the West. On the other hand, the success rate for containerized plants (small plants of the 10T size) is typically around 80 to 90 percent in the second growing season. Even if one assumes the willow stakes are free, there is still a cost involved in collecting, preparation of the woody material, transporting, and planting of the stakes. In addition, three times the number of willow stakes would be needed to equal the survival rates of the containerized plants. When this is done, the costs are either the same or actually less for the

containerized plants. If there is a cost associated with obtaining the willow stakes, then the containerized material is substantially less costly. (For cost analysis, the entire process involved with collection, preparation, and planting of willow stakes versus growing and planting of containerized material was compared.) In addition, one does not have to deal with either a visual concern or a safety concern of having a series of "wooden stakes" sticking out of the ground and being a hazard for the public.

– Root-control bags are an excellent way to grow large plants in a short period of time. Some of the benefits of root-control bags include simple, cheap, and quick harvesting; retainage of 80 percent of the root system during harvesting, as opposed to up to 98 percent of the actively growing tree roots cut away during normal digging procedures; lower production costs; better quality plants mean better survivability; plant re-establishment is minimal; and smaller ball size means lower transportation and handling costs. Once planted, all holes need to be backfilled with soil and drenched with water to wash the soil around the roots to remove air pockets and to water the new transplants.

– Tipped-over *Salix exigua* (sandbar willow) can serve as drag control along the highly erosive streambanks and reduce the force of the river on the immediate streambank. The plants can be harvested with a backhoe, placed in a dump truck for transportation to the site, and off-loaded onto the ground. It is not necessary to be careful about keeping all of the soil with the roots. The plants can be placed using a backhoe. Root-control bag *Salix exigua* (sandbar willow) can be substituted for mature willows if there is a concern about finding enough plants for the treatment from the Clark Fork River floodplain. Immediately after placement, all holes need to be backfilled with soil and soaked with water to wash the soil around the root to reduce air pockets and to water the new transplants. The tipped-over *Salix exigua* (sandbar willow) will be placed, on average, approximately 15 feet apart. The actual distance will vary depending upon the amount of erosive forces being exerted on a particular streambank. During the planting process, techniques will be employed to avoid creating fracture lines along the streambank.

– Watering newly vegetated areas will enhance the vegetation's survival rate. Irrigation, combined with planting sprigs and transplants closer to the water table, should address the need for water. However, implementation must not compromise bank stability. *Salix exigua* (sandbar willow) represents 95 percent of the willow vegetation in this zone along the Clark Fork River.

– The *Salix exigua* (sandbar willow) will spread by rhizomes through time. It can be spaced far enough apart to allow approximately 5 years of growth to produce continuous cover.

– *Betula occidentalis* (water birch) will work in most areas and should be incorporated in the design. This species is a good anchor plant, but should not be expected to propagate like *Salix exigua* (sandbar willow) for spreading across the floodplain.

– Augering or other devices will be used as the primary method of creating a hole for transplants. An auger can be mounted on the back of a truck or trailer. This facilitates the use of smaller, more mobile rigs, which also translates into a smaller footprint and less damage.

- **Mulching:** Application of mulch should be used to stabilize reseeded areas prior to establishment of the seeded vegetation. Mulch serves to decrease water erosion, reduce wind velocity, reduce soil crusting, decrease rainfall impact, and decrease soil surface temperature and evaporation. Most typically, cereal grain mulch is spread at a rate of 2 tons per acre and subsequently crimped into the soil. The use of a green mulch can also be considered.
- **Irrigation:** Water will be applied as necessary to implement the remedy, and the water rights necessary to do so will be acquired.
- **Weed control:** Weed species represent one of the single greatest threats to long term success of soil based remedial actions taken in the Clark Fork River OU. Prevention of weed invasion at each site will require integrative management of many different factors, including preexisting weedy vegetation, proximity of weed seed source, density of vegetation established during reclamation, grazing practices following reclamation, competition among other species present, herbicide control programs, biological controls indigenous to the site, and other factors. A Weed Management Plan is described in Section 13.10, page 2-123.
- **Monitoring:** Monitoring of remediated areas is required to demonstrate that the Performance Standards described in this *Record of Decision* document have been met. Details of the Monitoring Program are described in Section 13.11.4, page 2-134.

13.8.3 Wetlands, Ponds, Marshes, and Irrigation Ditches

Wetlands, ponds, and marshes are common within the floodplain along the Clark Fork River and will be evaluated by CFR RipES. If vegetation is robust and tailings are not visible the area will not be remediated. If vegetation is impacted and tailings are visible, greater than 2 feet in thickness, or saturated, the contaminated material will be removed and replaced in a manner that re-establishes a productive and healthy wetland. If vegetation is impacted and the tailings and contaminated soils are less than 2 feet thick and not saturated, the area will be treated in-situ.

The Selected Remedy seeks to enhance areas near existing wetlands ponds and marshes, and to create new wetlands where there are willing landowners and where ideal opportunities for new wetlands present themselves during remedy implementation. Such areas must be sufficiently distant from the active channel so as not to contribute to the floodplain's susceptibility to destabilization during remedy implementation.

Historic and active irrigation/drainage ditches bisect the Deer Lodge Valley (Reach A) in a complex pattern of linear features. It is uncertain how many of these ditches may have conveyed contaminated water from the Clark Fork River. Ditches located within the historic 100 year floodplain (Clark Fork River OU boundaries) will be delineated on aerial photographs (showing existing property boundaries) with other topographic features. They will be incorporated into polygons established by the CFR RipES process and subject to the sampling and assessment procedures associated with that process (during remedial design). Remedial action will depend on the results of the CFR RipES assessment (particularly arsenic concentrations), but could include a variety of activities, such as the physical removal of visible tailings, in-situ treatment of impacted soils, complete abandonment of specific sections of ditches through grading and backfilling as part of the treatment process, construction of a new ditch as a replacement (if the ditch is active), or other measures. Historic ditches located outside of the historic floodplain will be evaluated case by case during remedial design.

13.9 The Role of ICs, BMPs, and Land Use Plans

As described in the Selected Remedy, BMP land use plans (defined as land management strategies) are proposed as important, supplementary parts of the Selected Remedy. General descriptions of BMPs that EPA sees as necessary to support a successful remedy are presented in the following text. Although the primary function of ICs and BMPs at the Clark Fork River OU is to support remedial objectives, attendant secondary benefits may be realized through their implementation, including improvements in wildlife habitat and livestock forage. Application of the remedy is not limited to implementation of BMPs.

13.9.1 Best Management Practice Plans (BMPs)

BMPs may be implemented by contractual agreements between private landowners, or by incentive based government programs such as the Federal Environmental Quality Incentives Program (EQIP) or the actions of local Conservation Districts. The main land use of the Clark Fork River floodplain is agricultural, thus the focus of BMPs is directed toward agricultural practices, particularly those associated with livestock grazing. Over the longterm, the objective of land use BMPs is to maintain the integrity of the remedial actions. A comprehensive monitoring plan will be developed as part of a ranch management plan. The construction phase of the remedy represents another arena for application of BMPs. Construction BMPs are discussed in more detail in Section 13.6.2, page 2-104. The following text discusses additional rationale and details for the implementation of grazing and other related BMPs.

The development of proper grazing strategies and BMPs is critical to the success of EPA's remedy for the Clark Fork River. These plans will be owner-specific, and ensure that revegetated areas—whether the subject of removal of contaminants, in-place treatment of contaminants, or contaminants left in place—are appropriately managed so that operation and maintenance (O&M) of these areas can occur and so that the important revegetation efforts are protective, comply with performance standards, and are sustained over time. The plans also ensure continued access, at appropriate times, by the agencies and their designees, as well as Atlantic Richfield Company personnel, to monitor and maintain the remedy. BMPs for removed areas would likely be less extensive and may discontinue once vegetation has achieved the desired performance standards. EPA believes it essential that these efforts are implemented on a wide scale within the Clark Fork River OU, and funded by the PRP in cooperation with the Department of Agriculture and local conservation boards. These efforts do not replace monitoring, O&M, or future work activities that remain the responsibility of the PRP.

In this section, EPA discusses grazing strategies, BMPs, and the process involved in developing grazing management plans for various landowners along the Clark Fork River.

All remediated lands will be protected to allow adequate establishment and growth of new vegetation. Once this time has occurred, the land will be brought back into the normal land use activities as outlined by each landowner. Extra caution will be needed if annual crops are grown on remediated land to ensure that farming techniques do not leave bare ground in sensitive areas exposed to erosion for significant periods of time. The land will be monitored to ensure adequate growth and establishment of the vegetation, especially the woody vegetation along the streambank.

On grazing lands, riparian pastures will be established in the Clark Fork River OU. A riparian pasture can allow for forage use by livestock while reducing any impacts to woody vegetation. Once the remediation and revegetation has taken place, the riparian zone is expected to produce a much greater amount of forage than it produces today. A riparian pasture with an appropriate level of use can provide the best of both worlds—herbaceous forage production for the landowner ***and*** maximum growth of woody vegetation to protect against erosion, soil loss, and floodplain instability. The appropriate livestock use levels will be determined and will follow those outlined in the documents by Hansen 1993, Hansen 1994, Ehrhart and Hansen 1997, and Ehrhart and Hansen 1998. Additional information on grazing in riparian zones can be found in articles by Hansen et al. 1995, Hansen et al. 2000, Adams and Fitch 1998, Fitch and Ambrose 2003, and by the Montana DNRC 1995, 1999, and 2001. In general, the key to success will be to monitor the use levels of the woody vegetation and not just the use levels on the herbaceous vegetation.

Invasive plant (weed) control will be a critical element of remediation (see Section 13.10, page 2-123). An aggressive integrated weed management program will be implemented during the construction cycle. Any time soil is disturbed, weeds will try to invade; therefore, an herbaceous mixture of grasses and forbs will be seeded into all treatment areas. All sites will be monitored and treated for 5 years for weed infestations, as part of the post-construction monitoring process.

Grazing is a complex issue that does not lend itself to a simple, "one size fits all" answer. The development of a comprehensive management plan that deals with the importance of woody vegetation and reduced streambank impacts is essential for the health and well-being of the Clark Fork River floodplain. The landowner will be consulted to understand the vision they have for their piece of land. Once this is done, reasonable and attainable goals and objectives will be developed for their land. In some cases, no fences will be needed because the piece of land is used for hay production or a crop. In other situations, the existing large pasture may be cross-fenced to allow for a rotational grazing system that provides for reduced impacts (reduced browsing of woody vegetation and reduced streambank trampling) in the riparian zone and periods of rest resulting in a healthy riparian zone. In other cases, a fence running a couple hundred feet back from the stream, but parallel to the stream, will allow for the development of a riparian pasture. Riparian pastures are one of the most successful options for the following reasons:

1. When land is fenced "like-with-like" (in homogeneous units), landowners can more easily control livestock distribution.
2. Animal distribution is improved in both uplands and riparian areas, which will often allow the landowner to increase sustainable carrying capacity.

3. Providing effective control over livestock grazing during high risk periods allows for the most rapid recovery of riparian area health and productivity.

4. As a component of a landowner's riparian area goal, a riparian pasture will help restore and maintain woody vegetation.

Finally, only as a last resort would fencing of a narrow riparian corridor (for example, the approximate 50-foot corridor) be attempted. These narrow corridors are too small to effectively manage except as an exclusion zone from livestock grazing. Corridor fencing may be done for those situations where the landscape and property ownership boundaries preclude one of the other options. In other words, corridor fencing will be considered for those riparian areas where all other management options would fail.

Livestock grazing and proper riparian management are not incompatible goals. There are examples of working ranches with healthy riparian systems throughout North America that did not eliminate grazing from the riparian zone. What was eliminated was improper grazing, not all grazing.

A set of BMPs does not mean a landowner will have a functioning and healthy riparian zone. Usually, the step that is missed is the development of a ranch management plan that takes the generalized ideas of a BMP and develops reasonable and attainable objectives specific to each piece of ground. The BMPs are really the overall goals for a piece of land, while the objectives are the specifics as to how those goals will be met. For example, a goal (BMP) may be to reduce browse levels on woody vegetation to allow for the growth and maintenance of a shrubby corridor near the river. Another goal (BMP) may be to reduce streambank trampling and shearing. These goals do not tell a landowner how to accomplish them. That is where a riparian management plan comes into play and the goals are made specific for a piece of land.

Appendix C contains a list of key ideas to keep in mind when developing BMPs (goals) and a riparian management plan (Ehrhart and Hansen 1997 and 1998). Appendix C also contains a discussion on the process involved in developing a riparian or wetland ranch management plan (Hansen 1993 and 1994). Ranch management plans along the Clark Fork River will be based on this process.

Grazing of the remediated sites will be allowed based upon the criteria defined in the vegetation and performance section (Section 13.11.1.2, page 2-128).

ICs necessary for the Selected Remedy are identified in the human health component of this *Record of Decision*. In addition, supplemental ICs, such as conservation easements or deed restrictions, may be useful for lands addressed by the remedy. EPA will continue to explore these types of ICs during the remedial design process.

13.9.2 Off-Site Livestock Watering

In cases where livestock access to drinking water from the river is prevented by the need to protect remedial treatment, off-site provision for livestock water will be made. Such provisions may be temporary (e.g., during the construction work) or permanent, depending on the individual situation and the overall ranch management plan.

13.9.3 Fencing

Fencing will be used to accomplish objectives only as a last resort, or in accordance with the larger management plan for a particular property. Two types of fencing will be employed: temporary electric fence, and permanent fence.

Those remediated sites outside the streambank and riparian corridor buffer zone will be temporarily fenced to allow establishment of the newly planted vegetation. This will take approximately 2 years.

The revegetated remediated lands and stabilized eroding streambanks must be protected from livestock for the first few critical years. The timeframe will be a minimum of 5 years. A more detailed set of criteria are identified in the vegetation performance standards section. The intent is to protect these investments long enough for the newly planted vegetation to become established. For each property, the problem will be treated individually to find a solution that best meets the needs of the remedial action, as well as the requirements outlined in the ranch management plan and the vegetation performance standards.

An array of potential tools will be available to accomplish this protection. Among these are temporary fencing, permanent fencing, off-site watering, and riparian pastures.

Fencing is to be maintained by the potentially responsible party or remedy implementor until the remedy is determined to be operational and functional and 5 years of monitoring has occurred. After that, fencing may be required under BMPs and will be the responsibility of the landowner. The timeframe associated with this determination will be different based on whether it is within or outside the streambank and riparian corridor buffer zone.

13.10 Weed Management Plan

13.10.1 Invasive Plant Species Management

Invasive plants specialize in colonizing disturbed ground. They possess a number of physical traits that allow them to arrive at disturbed sites sooner and grow faster than other plants. With these advantages, they are able to out-compete native species, at least for a time. To counter this, EPA plans to avoid disturbing existing vegetation whenever possible. Such disturbance exposes the soil surface and reduces desirable vegetation, creating ideal opportunities for weed colonization. If disturbance cannot be avoided, all disturbed areas would be re-seeded or re-planted immediately. Native species or carefully chosen non-invasive introduced species will be used so that “vacant” or bare ground is quickly occupied by desirable plants.

Weeds also invade plant communities that have been degraded by land management practices that expose the soil surface and stress the desirable vegetation. Healthy native plant communities resist weed invasion. One of the best ways to avoid damaging plant communities is to manage livestock grazing to maintain good vigor of native perennial vegetation, especially grasses. Recreationists can also damage vegetation by overusing popular camping areas and creating trails. Dense, vigorous stands of perennial grasses are highly resistant to weed invasion. However, certain very aggressive weeds such as leafy spurge (*Euphorbia esula*), spotted knapweed (*Centaurea maculosa*), and Canada thistle (*Cirsium arvense*) can invade even well managed lands that have dense, vigorous vegetation.

All remedial activities on a property will follow strict guidelines for preventing the spread or introduction of invasive species to the site. Specific practices designed to avoid transporting weed materials and introducing weeds will be strictly followed and monitored. These will include the following:

- Educating all project personnel in weed identification and prevention. Local Weed Boards, such as the Powell County Weed Board, can provide assistance in this process.
- Assuring that all equipment used in remediation (including all vehicles and digging tools) be thoroughly washed and inspected for plant matter before entering the OU, and before entering a new property or new site.
- Requiring adherence by all personnel on site to prescribed practices for prevention of weed dispersal.
- Minimizing movement of personnel and vehicles on the property, and limiting access to specifically identified necessary routes, parking, and staging points.
- Designing all work to minimize soil surface disturbance.
- Re-vegetating all disturbed soil surfaces with appropriate vegetation (e.g., native species, including agronomic varieties for rangelands, and appropriate species for croplands, such as alfalfa) to deny opportunity to invasive species.
- Identification and control of pre-existing weed populations on the site to remove nearby sources of invasive species.

13.10.2 Invasive Plant Species Management

Control of invasive plants will be an integral and critical component of remediation. An aggressive integrated weed management program will be implemented during the construction cycle. An integral part of the remedial plan for every site upon which remedial work is done will include a comprehensive plan for controlling weeds. The approach taken is that all weeds will be controlled on property within the Clark Fork River OU upon which remedial work is completed. This is the best way to minimize the possibility that weeds from nearby sites would invade remediated areas. An aggressive campaign to control weeds already on a site will be undertaken concurrently with any other remedial work being performed.

Upon entry onto a property for commencement of remedial site assessment (application of CFR RipES, etc.), a weed inventory will also be conducted to locate and identify existing weed populations. With this information, an invasive species control plan specific to the site will be written and implemented in a manner integral to other work. Planning and implementation of invasive species control efforts will be conducted in collaboration with local weed authorities, such as the Powell County Weed Board.

A list of invasive species known to occur within the Clark Fork River OU is compiled below in Section 13.10.2.1. Specific information for each species about ecology, dispersal mechanisms, prevention techniques, eradication techniques, and other factors is contained in Appendix D. The information for this list came from a variety of sources, including our previous work experience and field data on the Clark Fork River OU (RWRP 1996), the

Center for Invasive Plant Management (CIPM 2003), the Montana Weed Control Association (2003), and the Colorado Department of Agriculture (2000). The occurrence of additional weed species within the Clark Fork River OU is possible. Any such occurrence encountered during the Clark Fork River OU cleanup will be addressed in a similar, species-specific and site-specific manner to control the spread and eliminate the infestation.

Invasive species will be monitored and any re-infestations will be treated for 5 years after the remedial construction and re-vegetation phase of the work is completed on each site as part of the post-construction monitoring process. After 5 years, weed management becomes the responsibility of the landowners.

Invasive species management during and after the remedial implementation phase will require coordination between the landowners and various governmental and private entities. Weed management is continually researched throughout the world. Various methods of control have been shown to work in a variety of conditions, including biological control (insects and pathogens), herbicides, grazing, mowing, hand pulling, and cultural practices. In most cases, a combination of several of these methods in conjunction with persistent monitoring and prevention measures will result in effective weed management. This combination of several methods into a site-specific and species-specific approach is called Integrated Weed Management.

13.10.2.1 Invasive Species of the Clark Fork River OU

Several invasive plant species are already well established within the Clark Fork River OU, while several others have a limited occurrence in Reach A. Some species are among the most commonly encountered plants in some areas, while others are rare thus far. Included below is a list of twelve species of invasive plants. Brief individual fact sheets are provided for each weed species in Appendix D. The information for this list came from a variety of sources, including the Center for Invasive Plant Management at MSU (CIPM 2003), and the Colorado Department of Agriculture (2000). The species include the following:

- Canada thistle (*Cirsium arvense*)
- Common Tansy (*Tanacetum vulgare*)
- Dalmatian toadflax (*Linaria dalmatica*)
- Houndstongue (*Cynoglossum officinale*)
- Kochia (*Kochia scoparia*)
- Leafy spurge (*Euphorbia esula*)
- Perennial pepperweed (*Lepidium latifolium*)
- Russian olive (*Elaeagnus angustifolia*)
- Russian thistle (*Salsola iberica*)
- Spotted knapweed (*Centaurea maculosa*)
- Yellow toadflax (*Linaria vulgaris*)
- Whitetop (*Cardaria draba*)

13.10.3 Integrated Weed Management Options

On each remedial site, a plan for management and control of invasive species will be written to address those weeds already present, as well as the potential for further invasion. Taken into account will be the unique set of physical site and managerial factors identified for the property in consultation with the landowner and other involved parties. This plan will be designed as an Integrated Weed Management approach based on the invasive species identified. It will draw from individually prescribed practices for each weed species using such options as those described in Appendix D (CIPM 2003, Colorado Department of Agriculture 2000). The individual Weed Plans will be filed with the local Weed Boards.

When establishing an integrated weed management plan as part of the Selected Remedy, EPA's ultimate goal is to restore and maintain a healthy desired plant community. It may not be realistic to expect that the land will be completely weed-free, even after years of weed management. Instead, getting weeds under control, by not spreading and not choking out the desired plant community growth, is the overall goal. Therefore, it is necessary to choose accordingly and realistically when deciding which methods to implement on a site-specific basis.

13.10.4 Monitoring and Evaluation

Information on monitoring and evaluation used is from a variety of sources including CIPM at MSU (2003) and the Colorado Department of Agriculture (2000). Monitoring is an essential component of a weed control program. Monitoring is the repeated collection and analysis of information to evaluate progress in meeting resource management objectives. Periodic observation of weeds being managed is necessary to evaluate the effectiveness of a weed control program. Monitoring saves money by helping to determine what is working and what is not. If EPA management objectives are not being met, weed control actions would need to be modified. Appendix D lists factors involved in an integrated weed management monitoring and evaluation plan (CIPM 2003, Colorado Department of Agriculture 2000).

13.11 Performance Standards and Remedial Goals

This section of the *Record of Decision* describes performance standards and performance evaluations for vegetation, groundwater, and surface waters.

13.11.1 Performance Standards for Streambank Corridor and Dysfunctional Plant Communities

The RAOs for floodplain tailings and impacted soils are as follows:

- Prevent or inhibit ingestion of arsenic-contaminated soils/tailings where ingestion or contact would pose an unacceptable health risk.
- Prevent or reduce unacceptable risk to ecological (including agricultural, aquatic, and terrestrial) systems degraded by contaminated soils/tailings.

Implementation of the Selected Remedy will accomplish these objectives.

The Selected Remedy must be compliant with ARARs or appropriate waivers as established for the Clark Fork River OU, described in Appendix A to this *Record of Decision*. There are one set of performance standards for the cleanup.

Successful reclamation of land contaminated by mining activities within the Clark Fork River OU is defined as establishing plant communities capable of stabilizing soils against wind and water erosion, reducing transport of COCs to groundwater and surface water, and compliance with ARARs or replacement standards, in perpetuity. Goals of the plant community are to establish a permanent vegetative cover to accomplish the following:

- Minimize direct contact with arsenic, thus reducing the potential risk of human exposure to acceptable risk-based levels.
- Provide geomorphic stability to streambanks, thus minimizing release of COCs to the river.
- Improve agricultural production by reducing or eliminating phytotoxic conditions, thus providing for multiple land uses.
- Minimize surface water erosion and COC transport to surface water through methods described in the Selected Remedy.
- Minimize transport of COCs to groundwater.
- Minimize wind erosion and movement of contaminated soils onto adjacent lands, thus eliminating human, agricultural, and wildlife exposure.
- Remediate contaminated soils to be compatible with the existing and anticipated future land use with minimal future maintenance activities.

Woody vegetation is an important factor in channel roughness and the dissipation of the streams' energy. Woody vegetation filters out sediments and provides for floodplain stabilization. Sedges, rushes, grasses, and forbs capture and filter out finer materials while their root masses aid in stabilizing floodplains by capturing filtered sediments. On sites where the potential exists for both woody and herbaceous vegetation, the cumulative effect of plant diversity greatly enhances stream function. Woody and herbaceous vegetation performance standards will be developed during remedial design and will include the following:

- Specific browse levels on woody vegetation to allow for the growth and maintenance of a riparian corridor of deep, binding woody vegetation near the river.
- Specific levels of streambank stability to limit streambank erosion and shearing. Streambanks will be designed for the 10-year return flow.
- The development and/or maintenance of different age classes of the key woody plant species on the site in order to maintain a viable self-sustaining plant community (e.g., seedlings, saplings, poles, and mature age classes for trees; seedlings, saplings, and mature age classes for shrubs).
- Specific levels of herbaceous vegetation stubble height will be established. Herbaceous vegetation stubble is required to trap and hold sediment deposits during run-off events and to aid in rebuilding streambanks and restoring and/or recharging aquifers.

13.11.1.1 Rootzone Performance Standards

The performance standards for treated soils are the same as those specified as rootzone design criteria described earlier in the *Record of Decision*, and include specifications for pH, acid/base account, organic matter, and concentrations of soil arsenic that relate to human health action levels and land uses. Rootzone performance standards will be measured at approximately two sample pits per acre, depending on site specific conditions.

- Soil arsenic concentrations in the 0 to 2 inches soil interval must be less than the human health action level for the current or reasonably anticipated land use. Confirmation sampling of the treated soil or the imported soil (after final grading) is required. The upper confidence limit of the mean soil arsenic concentration is to be evaluated in relation to the exposure unit.
- The pH of the treated growth media must be greater than 6.5, or greater than 7.0 if neutralizing amendments are used in the implementation of the action. The maximum acceptable pH is 8.5. The pH of the treated soils within a polygon is to be determined in the same samples collected for acid base account.
- The acid/base account of the treated growth media must be greater than zero. The acid base account of the treated soils within a polygon is to be determined with a minimum of two sample pits per acre. Incremental samples, at 6-inch intervals, are to be collected from within the treated zone and acid base account of each sample is to be equal to or greater than zero. The goal is to achieve neutralization within the entire treated zone.
- The organic matter content within the treated rootzone in riparian areas must be equivalent to organic matter (approximately 5 to 7 percent) in adjacent, non-contaminated riparian soils. For upland areas, the organic matter in the top 6 inches of the treated growth media must be 1.5 percent. At least one confirmation sample is required per polygon of treated soil or imported soil, with large polygons requiring multiple confirmational samples.

13.11.1.2 Vegetation Performance Standards

Performance of vegetation is to be integrated into specific remedial designs based primarily on end land use; thus, each land unit may have site-specific vegetation performance standards. The use of native species for revegetation will be emphasized for some open space areas, while appropriate agronomic species may be used in other areas. Vegetation performance attributes may include, but will not be limited to, the following:

- Woody browse levels
- Completeness of the canopy within the streambank buffer
- Vegetation cover
- Production
- Species richness
- Structural diversity
- Maturation periods
- Plant reproduction
- Evidence of successional processes

The relative importance of a characteristic is driven by the land management objectives. Agricultural production objectives would favor high forage value and high production with limited emphasis placed on species and structural diversity. Wildlife values are the inverse, with better habitat value associated with structurally complex vegetation and species diversity. The degree to which the remedy is able to satisfy the objectives of the landowner is dependent on the management objectives for a specific land area. Native vegetation—such as grasses, shrubs, and trees—will be specified for many areas that will receive remedial actions. For other areas, the vegetation community to be established will depend on current and future land uses. Remediated areas that are to be used for intense agricultural production—for example, irrigated alfalfa—will be seeded with appropriate agronomic species. Recommended performance standards are provided in Exhibits 2-26 through 2-28 (pages 2-130 and 2-132) and are grouped by post-remedial land use and landscape position. The standards are chiefly based on historical data for areas within the Clark Fork River that have been remediated or those that have been assessed in research and demonstration projects conducted within the basin during the last 20 years. ***Note:*** In many riparian plant communities, greater diversity means earlier seral, disturbed conditions. Some healthy, natural communities are monocultures (such as common cattail or sedge stands).

Methods to evaluate soil and vegetation performance standards are to be provided in remedial action construction quality assurance plans and in remedial action monitoring and maintenance plans. Assessments or points of compliance are to be conducted on a remedial polygon by polygon basis. Timing of evaluations relates to the determination of when remedy becomes operational and functional, and other monitoring and maintenance requirements as described below.

The performance of remedial efforts to reach minimum standards in terms of survival of live plant installation, vegetation composition, and canopy cover on areas within the historic 100-year floodplain will be assessed on a CFR RipES polygon basis. There are separate standards or guidelines for areas within the approximate 50-ft streambank riparian buffer zone and for areas outside the streambank riparian buffer zone. These performance standards and guidelines are written to assure the achievement of ultimate targets at 10 years from initial remedial treatment. Interim targets at intervals of 1, 2, 4, and 7 years out from initial remedial treatment are designed as checkpoints to assess that progress is being made along a trajectory that will reach the ultimate performance standard after 10 years.

In general, remedial efforts are not intended to permanently exclude these areas from agricultural uses, such as livestock grazing. However, livestock will be excluded from these areas for varying amounts of time while the vegetation in the newly implemented treatments becomes established. After minimal standards are met as prescribed, and in accordance with a ranch management plan written to achieve maintenance of remedial objective functions, livestock may be grazed on these areas within the stated guidelines specific to each property.

Polygons Within the Streambank Riparian Buffer Zone. On polygons within the streambank riparian buffer zone, there are two main concerns:

1. Achieving at least 80 percent canopy cover of preferred species of woody plants as quickly as practicable to control streambank erosion.

2. Achieving and maintaining an essentially complete (98 percent) canopy cover of combined woody and herbaceous perennial vegetation to prevent invasion of weeds.

Exhibit 2-26 presents interim survival rate targets for planted woody plants, canopy cover of preferred woody species, and total canopy cover of non-weed perennial vegetation (woody and herbaceous together). Overall guidelines for livestock grazing use are also included.

Livestock may be grazed on streambank riparian buffer zone areas only when the CFR RipES polygon vegetation has obtained a minimum canopy cover of 50 percent for preferred woody species and 98 percent total canopy cover of perennial vegetation. With proper livestock management, the percent preferred woody species canopy cover of 80 percent will be met 10 years after implementation of remedy. Other, more site specific, guidelines may also apply, as written into the particular ranch management plan for the property.

EXHIBIT 2-26
Vegetation Minimum Performance Standards and Guidelines to be Met on Streambank Riparian Buffer Zone Polygons

After Year Number	Percent Planted Woody Species Survival	Percent Preferred Woody Species Canopy Cover	Percent Total Canopy Cover of Non Weed Perennial Vegetation	Livestock Grazing Allowed if Other Criteria Are Met
1	90	NA	90-98	No
2	90	NA	95-98	No
4	X[1]	NA	98	No
5	X[1]	50	98	Yes[2]
7	X[1]	60	98	Yes[2]
10	NA	80	98	Yes[2]

[1]Any area 10 ft by 10 ft, or larger, lacking live plants of preferred woody species must be replanted with bag plants (not seedlings) of the same species at the original spacing and augered down to the capillary fringe of the water table.

[2] Livestock grazing in the streambank riparian buffer zone may be allowed 5 years after implementation of remedial treatment, when the CFR RipES polygon has exceeded all minimum canopy cover vegetation standards, and in compliance with ranch management plan language specifically written for streambank riparian buffer zone sites.

Preferred Woody Vegetation. Periodic monitoring will be conducted to assure progress on a community development trajectory that will achieve the required final minimum performance standards at 10 years after remedial implementation. Following remedial implementation on a CFR RipES polygon, these interim and final performance standards are required:

- Year 1: There must be 90 percent survival of the original planted material by species. Replant to the original number of plants any species that has less than 90 percent survival.
- Year 2: Same as Year 1.
- Year 4: There can be no openings without live plants of preferred woody species larger than approximately 10 feet by 10 feet. Replant any openings greater than approximately 10 feet by 10 feet with bag plants (e.g., not seedlings) at the original spacing. These re-plantings must be done so that the plant roots reach the water table or the ground water capillary fringe (this can be done with a portable power auger).
- Year 5: There must be 50 percent or more canopy cover of preferred woody species within the streambank riparian buffer zone CFR RipES polygon. If there is less than 50 percent, then replant with bag plants at original spacing, in order to achieve 50 percent canopy cover. Grazing allowed if all criteria are met.

- Year 7: There must be 60 percent or more canopy cover of preferred woody species within the streambank riparian buffer zone CFR RipES polygon. If there is less than 60 percent, then replant with bag plants at original spacing, in order to achieve 60 percent canopy cover.
- Year 10: There must be 80 percent or more canopy cover of preferred woody species within the streambank riparian buffer zone CFR RipES polygon. If there is less than 80 percent, then replant with bag plants at original spacing, in order to achieve 80 percent canopy cover.

Herbaceous Vegetation. Performance standards for herbaceous riparian vegetation will also be applied within the streambank riparian buffer zone. Standards are in terms of percent canopy cover attained for all vegetation on the polygon. Periodic monitoring will be conducted after remedial implementation to assure that the minimum standard is met and maintained. Following remedial implementation on a CFR RipES polygon, these interim and final performance standards are to be met:

- Year 1: There must be 98 percent canopy cover of the CFR RipES polygon by live vegetation. If there is less than 98 percent, determine cause(s) for failure, remediate any determined cause(s) for failure, and reseed all unvegetated areas.
- Year 2: Same as Year 1.
- Year 4: Same as Year 1.
- Year 7: Same as Year 1.
- Year 10: Same as Year 1.

Polygons Outside the Streambank Riparian Buffer Zone, but Within the Historic 100 Year Floodplain. Vegetation performance standards on polygons that lie outside the streambank riparian buffer zone are primarily aimed at achieving ground cover and productivity. These objectives are driven by the dual purposes of stabilizing any residual low levels of contamination and of meeting landowner operational needs. Success of vegetation remedial efforts will also be assessed on a CFR RipES polygon basis, and will be in terms of completeness of the canopy cover of all non-weed perennial vegetation. As on streambank riparian buffer zone polygons, the status of the vegetation should progress toward the ultimate goal of at least 98 percent canopy cover. Exhibit 2-27 presents the performance standard checkpoint intervals and grazing criteria. The herbaceous vegetation performance standard is the same as in the streambank riparian buffer zone.

Livestock are excluded for 2 years on areas that have received remedial treatment involving vegetation seeding or planting. After the initial 2-year period, livestock may be grazed on these areas if canopy cover of non-weed perennial vegetation reaches at least 98 percent, and in compliance with the management plan written for the property.

EXHIBIT 2-27
Vegetation Minimum Performance Standards and Guidelines to be Met on Polygons Outside the Streambank Riparian Buffer Zone

After Year Number	Percent Total Canopy Cover of Non-Weed Perennial Vegetation	Livestock Grazing Allowed if Other Criteria are Met
1	90-98	No
2	95-98	No
3	98	Yes[1]
5	98	Yes[1]

[1] Livestock may be grazed in accordance with a ranch management plan, if the non-weed perennial vegetation canopy cover is at least 98 percent.

Exhibit 2-28 represents performance standards for the non-riparian vegetation areas.

EXHIBIT 2-28
Performance Standards for Non-Riparian Vegetation

Post-remedial Land Use	Noxious Weeds & Undesirable Weedy Species	Minimum[a] Vegetation Cover by species	Minimum Species Richness[b]
Open Space and Wildlife Habitat	Zero tolerance policy for noxious weeds.	-	-
Upland Areas	Undesirable weedy species count a maximum of 5 percent toward vegetative assessment measurements.	45 percent live cover	5 species/100 m^2
Agricultural	same as above		
Upland Grazing		45 percent live cover	5 species/100 m^2
Crop		No cover standard, but production is to be statistically equivalent to County average production for that crop.	N/A
Recreational	same as above	45 percent live cover in upland areas, 100 percent in riparian areas	5 species/100 m^2 for upland areas,
Residential/Parks[c]	same as above	45 percent live cover in upland areas, 100 percent in riparian areas	Appropriate for type of residence or park

[a] Canopy cover method, noxious weeds count zero and undesirable weed species count a maximum of 5 percent toward live cover percentage.
[b] Each species must account for greater than or equal to 1 percent of the live plant canopy cover. Invasive species and undesirable weedy species do not count.
[c] This does not apply to the Grant-Kohrs Ranch National Historic Site.

13.11.1.3 Performance Standards of Streambank Treatments

Performance standards for streambank treatment work (monitoring of streambank remedial work and material installed to correct erosion problems apply to streambank reaches receiving remedial Treatment 2, Treatment 3, and Treatment 4) should be conducted from a raft or boat. The streambanks with either No Treatment Necessary or Treatment 1 will not be evaluated for erosion problems, unless erosion is determined to be caused by any of the other treatments (Treatments 2, 3, and 4). For other areas, the performance standards are as follows:

- Year 1: Replace or repair any installed streambank material that has failed, such as:
  - Erosion along the toe of the material
  - Erosion at either the upper or lower ends of the treatments
  - Repair/patch any tear of the coir fabric greater than 1 foot in length
- Year 2: Same as Year 1.
- Year 3: Same as Year 1.
- Year 5: Repair any failures (as discussed in Year 1) greater than 5 linear feet along the streambank. The repairs may include the use of either pre-vegetated coir logs or pre-vegetated roll sods that can be carried to the site and installed by hand.
- Year 10: Same as Year 5.

13.11.2 Performance Standards for Groundwater

The groundwater RAOs are as follows:

- Return contaminated shallow groundwater to its beneficial use within a reasonable time frame.
- Comply with State groundwater standards, including nondegradation standards.
- Prevent groundwater discharge containing arsenic and metals that would degrade surface waters.

Implementation of the Selected Remedy will accomplish these objectives. The Selected Remedy must be compliant with groundwater ARARs or appropriate waivers as established for the Clark Fork River OU, described in Appendix A.

Standards for groundwater are as follows (dissolved concentrations):

- Arsenic 10 μg/L*
- Cadmium 5 μg/L
- Copper 1,300 μg/L
- Iron 300 μg/L
- Lead 15 μg/L
- Zinc 2,000 μg/L

* = For wells used for domestic purposes, analysis shall be total, rather than dissolved.

Methods to evaluate groundwater performance standards, points of compliance, monitoring well locations and numbers, frequency of sampling and analysis, and reporting requirements are to be specified in remedial action monitoring and maintenance plans. EPA recognizes that there is uncertainty whether the Selected Remedy will achieve full compliance with these Performance Standards in all groundwater at all times. If full compliance is not achieved, EPA will consider alternatives to meet this standard, or, if warranted, invoke appropriate waivers of these standards. Timing of evaluations relates to the determination of when the remedy becomes operational and functional, and other monitoring and maintenance requirements as described below.

13.11.3 Performance Standards for Surface Water

Standards for surface waters provided in Exhibit 2-29 are based on a hardness of 100 mg/L using a total recoverable method, except for the waived copper standards and the arsenic human health standard. The copper and the Federal human health arsenic standards are based on the dissolved component.

EXHIBIT 2-29
Surface Water Standards[a]

	Acute	Chronic	Human Health
Arsenic	340 μg/L	150 μg/L	10/18 μg/L[b]
Cadmium	2 μg/L	0.25 μg/L	5 μg/L
Copper[c]	13 μg/L	9 μg/L	1,300 μg/L
Lead	81 μg/L	3.2 μg/L	15 μg/L
Zinc	119 μg/L	119 μg/L	2,000 μg/L

[a] Based on 100 mg/L hardness, total recoverable, acute, and chronic

[b] The performance standard includes both the Federal MCL, 10 μg/L, dissolved and the State WQB-7 standard, 18 μg/L, based on total recoverable analysis. Final determination of whether these standards will be consistently attained will depend upon upstream source control as well as implementation of this remedy.

[c] Federal Ambient Water Quality Criteria (dissolved; Gold Book 1986)

Methods to evaluate surface water performance standards, points of compliance, sample locations, frequency of sampling and analysis, and reporting requirements are to be specified in the Remedial Design documents. Timing of evaluations relates to the determination of when the remedy becomes operational and functional, and other monitoring and maintenance requirements as described below.

13.11.4 Performance Evaluations of the Selected Remedy

Following completion of Remedial Action, a need exists to maintain the remedy and demonstrate that the remedy is operational and functional, and ultimately that the remedy is successful. A Monitoring and Maintenance Plan is to be developed and is to include the following assessments of the success of the Selected Remedy by evaluating the following:

- Reductions in streambank erosion attained by the development of the riparian buffer zone corridor.
- Improvements in groundwater quality compared to Performance Standards for multiple points of compliance over a reasonable time period.

- Reduction of acute and chronic risks to aquatics as measured by biological surveys of fish densities, and benthic macroinvertebrate taxa richness and species diversity counts.
- Reduction of phytotoxicity as measured by vegetation attributes of cover, production, species richness, and successional trend.
- Reduction of risks to human health as evaluated by assessing arsenic concentrations in surface soils and comparing them to the established RBCs for specified land uses.
- Assessments of meeting Performance Standards established in this *Record of Decision,* including ARARs.

13.11.4.1 Operational and Functional

Remedial actions are to be evaluated during the post-construction period, and during the first, second, and third growing season, to rapidly demonstrate that the remedy is operational and functional and to trigger corrective actions immediately as problems are encountered. As part of construction implementation, the rootzone performance standards specified above are to be attained. Vegetation targets (Exhibit 2-28, page 2-132) are established for different land uses and landscape positions, specifically for the following:

- Wildlife
- Open space and grazing for upland areas
- Agricultural areas seeded to agronomic species in both upland and riparian areas

It is reasonable to expect attainment of these targets during the third growing season, although recurrent drought cycles may extend this period. To ascertain landscape stability and determine whether vegetation is on a trajectory to attain the performance standards, the following assessments are to be made during the first growing season following implementation of remedial action:

- General landscape stability—Evidence of rills and gullies; soil movement or mass instability will trigger corrective actions.
- Streambank stability—Assessments of the banks are to be conducted from a raft or boat. Evidence of erosion along the toe or erosion at either the upper or lower ends of the treated banks will trigger corrective actions. Tears in coir fabric greater than 1 foot long will also trigger corrective actions.
- Year 1 goal for woody vegetation is 90 percent survival of the original planted materials by species. Corrective actions may include replanting to original number of plants for a particular species.
- Year 1 goal for herbaceous vegetation in the riparian zone is 98 percent canopy cover of the seeded area. Corrective actions may include determining cause(s) for failure, correcting them, and reseeding.
- Year 1 goal for herbaceous vegetation in upland areas is a density of 40 stems per square meter for seeded species. Corrective actions may include determining cause(s) for failure, correcting them, and reseeding.

- Noxious weeds and undesirable weedy species are to be controlled as specified in Section 13.10, page 2-123.

13.11.4.2 Short-Term Monitoring

Following demonstration that the remedy is operational and functional, the site will be monitored for a period of years. The short-term performance phase will demonstrate the immediate success of the remedy in terms of streambank stabilization and preferred vegetation establishment. In addition to the vegetation cover, species richness, weed control and landscape stability conditions required under operational and functional, the short term performance monitoring phase will include broader evaluations of ecological trend and land utility.

This level of monitoring is conducted after remedial action(s) are implemented, and results are used to determine whether the action remains operational and functional. This level includes baseline measurements, qualitative assessments of the remedial action, and failure assessments. Failure of the remedial actions completed for specific areas within the Clark Fork River OU includes failure to comply with Performance Standards as described in this *Record of Decision*.

13.11.4.3 Long-Term Monitoring

Specific areas will be subjected to long-term monitoring after short-term monitoring, which may include the assessment of temporal changes using qualitative and quantitative assessments. These data and information are used to assess whether the Remedy has been implemented and whether Performance Standards are met. This period of monitoring is generally 6 to 20 years depending on the time required to achieve operation and functional status, changes in land use, and any on-going maintenance activities.

All of the abiotic and biotic monitoring—including plant communities growth media, erosional stability, aquatic communities, evidence of sustainability, and wildlife—will play significant roles in the assessments of achievement of ecological and health risk reduction and assessment of meeting ARARs.

13.11.4.4 Maintenance Program

Maintenance programs may include diagnostic evaluations for areas that are deemed to require a corrective action during the monitoring phase. Diagnostic evaluation may include assessment of soil or growth media parameters, appraisal of the implementation of the land reclamation remedial action, effects of climatic conditions on the vegetation community, seedbanks, and streambank evaluations. Control and mitigation of weeds are part of the maintenance program. A comprehensive O&M plan will be developed for all work at the site. Until the remedy is determined to be operational and functional and for a maximum of 5 years if fencing is needed that long, fencing required to protect the remedy will be maintained by the PRP. After that, fencing may have to be maintained for a longer period under BMPs and will be the responsibility of the landowner.

This comprehensive O&M plan will address, among other things, areas that require maintenance because of localized or total failures of the remedial actions. These areas are to be identified and diagnostic evaluations are to be conducted to help ascertain the reason(s) for failure. Diagnostic tests may include, but are not limited to, assessments of the following:

- Growth media in terms of fertility, pH, and levels of metals and arsenic
- Implementation practices
- Climatic conditions during and following implementation
- Seedbank evaluations

Corrective action(s) will be required when failures are shown.

13.11.5 Safety Concerns

Conducting a cleanup in a safe manner is a primary concern. Safety will be stressed throughout all aspects of the project. Other sections of the *Record of Decision* elaborate on why it is necessary to remove some of the most toxic wastes. EPA's experience with other sites where large scale removal has been done indicates this project can be conducted safely with careful planning.

Comments on the *Proposed Plan* specifically discussed the potential for inhalation of contaminated dust from construction activities. A concern regarding this inhalation is contrary to the findings of the *Human Health Risk Assessment*, which did not find the inhalation pathway for contaminants associated with agricultural tillage or disturbance to be a problem. It is also contrary to experience at other sites (Warm Springs Ponds, LAO, Butte Hill, Silver Bow Creek) where dust control during removal of wastes has been appropriately implemented and no adverse health effects have been suggested or demonstrated.

The safety risks posed by removing and hauling away the worst wastes to a secure disposal area can be controlled and managed. Past cleanup actions in the Clark Fork Basin have generally demonstrated this. However, it does require a high level of safety consciousness, good planning, and a commitment to coordination and cooperation with local County and city officials and residents. In 17 years of cleanup construction valued at hundreds of millions of dollars and involving the removal of millions of cubic yards of wastes in the Clark Fork Basin, there has been one construction worker fatality and only a very few other injuries, but no injuries to the public.

A primary consideration at the Clark Fork River project is to manage haul trucks safely. This includes planning to safely optimize truck traffic flows on major State and Federal highways, primary local county roads, and secondary access roads onto private property. EPA has consulted with construction specialists at the U.S. Bureau of Reclamation and with EPA's contractor, and believes that the project can be designed and implemented in a safe manner. The removal aspect of this project may result in 6 to 7 trucks per hour hauling wastes and backfill during the actual time of construction for the estimated 10-year construction period. A fairly comparable EPA construction project (removal action) was implemented several years ago near Deer Lodge for the East Side Road TCRA. On average, 4 to 6 trucks per hour operated safely on local roads for a period from approximately May through October with careful safety considerations. Other large scale construction projects, such as road construction and logging operations, commonly pose traffic safety risks and yet are effectively planned and implemented.

EPA will emphasize project safety in implementation. This particular project will require possible road paving and widening, the use of constructed designated roads in some areas, timed hauling, and other techniques to minimize public contact with the trucks hauling wastes and heavy equipment, and to ensure wide and stable enough roads where that contact may occur. The remedy will retain responsibility for road upgrades and EPA will work closely with local representatives. EPA believes the remedy can be safely implemented through good planning and engineering practices.

13.12 Scheduling

A schedule for remedial action on the Clark Fork River will be prepared during remedial design. At this time, the anticipated duration is 10 field construction seasons. Within that period, it is assumed that multiple crews will be working on several properties concurrently. A 2-year implementation target, per property, remains the EPA's goal. The accuracy of the 2-year remedial cleanup prediction will be dependent on the size and complexity of the property. Thus, the first step of implementation involves a CFR RipES evaluation and discussions with the landowner. These activities form the cornerstone of the level of effort to be applied to the property. The level of effort (site specific design) then dictates the construction timetable for that portion of the project. As this process is repeated for all the properties and applied to a construction season calendar, a rough timetable for the project will be developed.

A formal construction sequencing plan will be prepared during the design phase of the remedial action. The sequence of properties to be remediated throughout Reach A and localized areas of Reach B will be carefully planned and prepared. While the general approach will be to work from the headwaters down, EPA believes remediation can be done more quickly and effectively and with less threat to river stability by working on discontinuous stretches of the river. Thus, properties will be engaged in a discontinuous manner to prevent jeopardizing the integrity of the floodplain, should a flood event greater than the annual flood occur during the 10-season remedial action period. Affected landowners will be involved in setting these schedules and clearly informed of the sequencing of the work.

EPA recognizes that timing of the remedial actions is an important implementation issue. Again, a primary cleanup objective is to minimize the inconvenience to individual landowners. As previously stated, the overall project timeline for the 43 miles of river in Reach A and portions of Reach B is estimated to be approximately 10 years. This estimate may change during the design and construction phase. Individual landowner operating needs, availability of irrigation water, and the end land use determinations may also impact project schedules and timing.

13.13 Cost Estimate for the Selected Remedy

A cost estimate was developed to reflect EPA's determination of a final remedy for the Clark Fork River (separate document from this *Record of Decision*). To accomplish this, variations and additions to key alternatives described in the *Feasibility Study* (Atlantic Richfield Company 2002) and that reflects the Selected Remedy were defined and developed in sufficient detail for costing purposes. Major considerations included 1) defining streambank classes and lengths, and 2) better defining quantities and unit costs consistent with the Selected Remedy.

The costing format presented in the *Feasibility Study* was followed to facilitate cost comparisons of EPA's Proposed Remedy with various alternatives in the *Feasibility Study* during the remedy selection process. Where appropriate, adjustments to either unit costs or quantities were made by EPA. The changes, where warranted, reflect consideration of the Atlantic Richfield Company's RDU6 demonstration (Forson Property) design, and other currently available information available to the EPA as described in the "Notes" referenced in the cost tables. Details regarding methods utilized can be found in *Cost Estimate for the U.S. Environmental Protection Agency's Cleanup Plan for the Clark Fork River OU* (EPA 2003).

The Selected Remedy required specific changes and additions to key components of various combined alternatives previously considered and described in the *Feasibility Study* (Atlantic Richfield Company 2002). These required changes have now been defined in sufficient detail.

Major tasks included:

A. Re-estimated streambank classes, lengths and types of treatments commensurate with bioengineering streambank practices.

B. More refined quantities and unit costs for other components consistent with the other modifications described in EPA's *Proposed Plan* and Selected Remedy.

Most significant is the work that was done to denote streambank classes, levels, and lengths of treatment, and other requirements noted in EPA's *Proposed Plan*. Details regarding methods utilized for the first task can be found in Appendices A through E of the cost estimate document. Costing details for other components noted for the second task can be found in the "Notes" section, which supports Cost Tables for Reaches A and B (noted as Tables D-1 and D-2, respectively) of the cost estimate document.

The entire length of the Clark Fork River streambank in Reach A is 455,136 feet (86.2 miles), which is determined by doubling the reach channel length to account for both streambanks. Streambanks are classified based on stability and phytotoxicity (Class 1, 2, and 3 as defined in the Selected Remedy). Historic RI/FS data that described physical characteristics, which included the presence of visible tailings, the presence and condition of streambank vegetation with deep binding root mass, and degree of perceived phytotoxicity were used to re-estimate and update the condition of various streambanks and tributaries streambanks, consistent with the latest methodology as described by CFR RipES. The following is a brief description of what percentage of Reach A the previously defined streambank classes represent.

- **Class 1 Streambanks**—It was estimated that 20.0 percent of Reach A streambank length (87,287 feet or 16.53 miles) is considered a Class 1 Streambank.
- **Class 2 Streambanks**—It was estimated that 65.5 percent of the Reach A streambanks length (285,866 feet or 54.14 miles) is considered a Class 2 Streambank.
- **Class 3 Streambanks**—It was estimated that 14.5 percent of Reach A streambank length (63,283 feet or 11.99 miles) is considered a Class 3 Streambank.

Class 3 streambanks are those that support some appropriate deep, binding woody vegetation. Class 3 streambanks will require little, if any remedial treatment to assure continued stability.

Of the 455,136 total feet of streambank in Reach A, there is 18,700 feet (3.54 miles) of streambank that is currently rip-rapped or otherwise protected. These locations include the reach through the town of Deer Lodge, and along the railroad and road bridge crossings.

Based on data presented in the *Remedial Investigation* and the *Feasibility Study*, no streambank removal and reconfiguration will be necessary in Reach B. The data show no exposed tailings or buried tailings greater than 12 inches thick in contact with the present streambank of the river. Of the 6.23 acres of visible surface tailings recorded on the 52.1 percent of area inventoried (Atlantic Richfield Company 1998) within Reach B, about 500 linear feet of streambank are within 10 feet of the surface tailings. This extrapolates to about 960 total feet of streambank that may be within close proximity to visible surface tailings in Reach B. The tailings and contaminated soils will require some form of remediation consistent with remedial actions in Reach A.

Remedial treatments will be applied to appropriate streambank conditions on a reach by reach basis as defined and described previously. Recommended treatments (1 through 4, described in Appendix B) were defined, matched to appropriate streambank lengths and costed as part of this document.

Summarized in Exhibits 2-30 and 2-31 are the main channel streambank lengths, treatment levels, and streambank riparian buffer zone acreage defined by the above analysis in Reaches A and B, respectively.

EXHIBIT 2-30
Clark Fork River Reach A Streambank Treatments, Lengths, Percent of Total Length, and Acreage

Streambank Treatment	Linear Streambank Length (ft)	Percent of Total Length	Acres
No Treatment Necessary	25,313	5.6 percent	29.1
Treatment 1			
(Vegetation Augmentation)	95,144	20.9 percent	109.2
Treatment 2			
(Low Shear Stresses/Flow Velocities)	131,803	29.0 percent	151.3
Treatment 3			
(Moderate Shear Stresses/Flow Velocities)	128,923	28.3 percent	148.0
Treatment 4			
(High Shear Stresses/Flow Velocities)	55,253	12.1 percent	63.5
Currently Rip-Rapped	18,700	4.1 percent	—
Total	**455,136**	**100.0 percent**	**501.1**

EXHIBIT 2-31
Clark Fork River Reach B Streambank Treatments, Lengths, Percent of Total Length, and Acreage

Streambank Treatment	Linear Streambank Length (ft)	Percent of Total Length	Acres
Treatment 2			
(Low Shear Stresses/Flow Velocities)	192	20 percent	0.2
Treatment 3			
(Moderate Shear Stresses/Flow Velocities)	461	48 percent	0.5
Treatment 4			
(High Shear Stresses/Flow Velocities)	307	32 percent	0.4
Total	**960**	**100 percent**	**1.1**

Another component of the cost estimate development were the major and minor tributaries within the historic 100-year floodplain of the Clark Fork River requiring bank stabilization. Summarized in Exhibits 2-32 and 2-33 are the tributary channel lengths, treatment levels, and streambank riparian buffer zone acreage defined by the above analysis in Reach A. No secondary channels requiring upgrades were noted in Reach B.

EXHIBIT 2-32
Reach A Major Tributaries and Major Secondary Channels Streambank Treatments, Lengths, Percent of Total Length, and Acreage Assuming a 50-Foot Riparian Buffer Zone

Streambank Treatment	Linear Streambank Length (ft)	Percent of Total Length	Acres
No Treatment Necessary	6,020	29.8 percent	6.9
Treatment 1			
(Vegetation Augmentation)	6,780	33.6 percent	7.8
Treatment 2			
(Low Shear Stresses/Flow Velocities)	5,910	29.3 percent	6.8
Treatment 3			
(Moderate Shear Stresses/Flow Velocities)	1,380	6.8 percent	1.6
Treatment 4			
(High Shear Stresses/Flow Velocities)	110	0.5 percent	0.1
Total	**20,200**	**100.0 percent**	**23.2**

EXHIBIT 2-33
Reach A Minor Tributaries and Minor Secondary Channels Streambank Treatments, Lengths, Percent of Total Length, and Acreage Assuming a 25-Foot Riparian Buffer Zone

Streambank Treatment	Linear Streambank Length (ft)	Percent of Total Length	Acres
No Treatment Necessary	25,920	60.3 percent	14.9
Treatment 1			
(Vegetation Augmentation)	12,640	29.4 percent	7.2
Treatment 2			
(Low Shear Stresses/Flow Velocities)	3,730	8.7 percent	2.2
Treatment 3			
(Moderate Shear Stresses/Flow Velocities)	620	1.4 percent	0.4
Treatment 4			
(High Shear Stresses/Flow Velocities)	90	0.2 percent	0.1
Total	**43,000**	**100.0 percent**	**24.8**

Total Estimated Construction Costs for both Reaches A and B were developed after sufficient detail was developed for the key components of the cost structure. Total Construction Costs are defined as Capital Costs of various defined categories, plus Miscellaneous Costs, which includes such items as design engineering cost, contractor mobilization/demobilization costs, contractor profit, construction management costs, etc. In addition, a Maximum Estimated Construction Cost was also developed to establish an upper bound cost.

The **Base Case Cost Estimate** was composed of: "middle of the road" costs from the *Feasibility Study* (Atlantic Richfield Company, 2002), updates from the Atlantic Richfield Company's (Forson) RDU6 design, and costs and quantities as defined by EPA during this estimate preparation. The **Maximum Estimated Cost** was composed of the base case cost estimate plus an additional 20 percent, which was added either to the "quantity" or "unit cost" element. Capital costs are summarized in Exhibit 2-34.

EXHIBIT 2-34
Reaches A and B Total Construction Costs

Reach	Base Case Estimated Costs	Maximum Estimated Costs
Reach A		
Capital Costs	$67,960,237	$82,810,673
Misc. Costs	$23,786,083	$28,983,408
Subtotal—Reach A	$91,746,320	$111,794,081
Reach B		
Capital Costs	$3,483,703	$4,291,342
Misc. Costs	$1,219,296	$1,463,155
Subtotal—Reach B	$4,702,999	$5,754,497
Total Construction Costs-Reaches A & B	**$96,449,319**	**$117,548,423**

Annual Monitoring and Maintenance Costs were also determined for each Reach. Reach A Monitoring and Maintenance Estimated Costs are $1,826,514 and Reach B Monitoring and Maintenance Estimated Costs are $35,719.

Total Net Present Value (NPV) calculations were performed assuming three scenarios:

1. A 10-year construction period using the base case (middle of the road) estimated costs at a discount rate of 5 percent
2. A 15-year construction period using the maximum estimated (upper bound) costs at a discount rate of 5 percent
3. A 15-year construction period using the maximum estimated costs at a discount rate of 7 percent

The NPV for these three scenarios are shown in Exhibit 2-35. The NPV calculation assumes an annual inflation rate of 2 percent applied to construction cost.

EXHIBIT 2-35
Net Present Value for Costing Scenarios

Scenario	Construction Period	Costing Assumption	Discount Rate	Net Present Value
1	10 years	Base Case	5 percent	$122,017,549
2	15 years	Maximum Case	5 percent	$141,557,274
3	15 years	Maximum Case	7 percent	$117,338,024

The information in this cost estimate section is based on the best available information regarding the anticipated scope of the Selected Remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the Selected Remedy. (For example, actual slickens may encompass between 167 and 250 acres; impacted soils may range from 700 to 1,760 acres.) Major changes may be documented in the form of a memorandum to the Administrative Record file, an Explanation of Significant Differences, or *Record of Decision* amendment.

13.14 Estimated Outcomes of Selected Remedy

Exhibit 2-36 presents a summary of the anticipated outcomes of the Selected Remedy by river reach with regards to land use, groundwater use, and human and ecological risk reduction as a result of the response action.

EXHIBIT 2-36
Expected Outcomes for the Selected Remedy

Site Scenario	Exposure controlled through treatment, off-site disposal of source material, and institutional controls
	Deer Lodge Valley
Land Use and Time Frame	The overall project timeline for the 43 miles of river in Reach A and portions of Reach B is projected to be up to 10 years. The Selected Remedy calls for managing land use for a flexible distance, which may be within 50 feet of the river. The Selected Remedy is designed to allow as much of the historical use as possible while still maintaining the effectiveness of the cleanup. An IC calls for County zoning requirements to limit residential use of floodplain areas where waste is left in place. It is not anticipated that the floodplain in Reach A and parts of Reach B will be suitable for residential human occupation, in spite of the proposed remedial efforts. With some limitations tied to the progress of the vegetative re-growth in remediated areas, most of the floodplain is anticipated to support agricultural uses (e.g. grazing, hay production, etc.). BMPs will be long-term actions, along with operation and maintenance and monitoring activities. The exact length of time for these activities will vary for each land unit.
Groundwater Use and Time Frame	Compliance with groundwater ARARs and standards is not expected immediately, but may occur within a reasonable time frame as a result of a combination of the Selected Remedy and natural attenuation. An IC calls for prevention of use of shallow groundwater for domestic consumption or other consumptions that may spread the groundwater contamination at the OU until groundwater cleanup is achieved. It is anticipated that this condition may persist for several decades after the remedial action has been implemented. Post-construction monitoring will provide a gauge for judging long-term conditions.
Anticipated socio-economic and community revitalization impacts	By remediating slickens areas on ranches, more land will be placed into production, which may help the ranching and farming economy. Also, Reach A is home to the Grant-Kohrs Ranch National Historic Site, as well as other historic areas (such as the old penitentiary at Deer Lodge). Improving water quality in the Clark Fork River through application of the Selected Remedy may improve conditions for fish and other aquatic receptors by reducing chronic and acute risks. This could make the Deer Lodge Valley a more attractive center for recreation, while also helping to preserve the existing agricultural economy.
Anticipated environmental and ecological benefits:	
Streambank Erosion	Reduction of streambank erosion through streambank stabilization and treatment of slickens areas is expected to reduce sedimentation and runoff to the river. It is also expected to help preserve the land base and reduce the land loss resulting from erosion to a level comparable with other Montana streams.
Geomorphic Stability	The USGS has indicated in their studies that the river is at risk of floodplain destabilization because of accelerated erosion rates above background levels. By stabilizing the streambanks and removing slickens areas along with backfilling and revegetation, this risk is expected to be reduced.

EXHIBIT 2-36
Expected Outcomes for the Selected Remedy

Site Scenario	Exposure controlled through treatment, off-site disposal of source material, and institutional controls
Water Quality	According to modeling projections, none of the alternatives considered are expected to fully comply with the State water quality standard for copper, and a waiver of the copper standard is justified. EPA believes the replacement copper standard can be achieved, and the improved water quality and eliminated pulse events will improve conditions for fish and other aquatic receptors. All other surface water quality ARARs are expected to be achieved. The Selected Remedy is expected to reduce the amount of fine-grained contaminated sediment in the river bed. The Selected Remedy is expected to provide a greater reduction in mobility and volume of contaminants by removal of wastes from the floodplain.
Phytotoxicity	The Selected Remedy is expected to reduce the phytotoxicity of contaminated soil and tailings through removal and in-situ treatment or combinations of these techniques. The final growth media will be capable of supporting vegetation compatible with current and anticipated future land uses.
Human Health	The Selected Remedy is expected to reduce contaminated soil and tailings arsenic concentrations to below the designated RBCs for reasonably anticipated land uses through treatment, removal, or combinations of these techniques. The performance standards for groundwater are based on human health risk standards. Educational measures are expected to help prevent ingestion of or direct contact with contaminated soils and further reduce risks to children, especially pica children, who are medically prone to eating dirt.

Cleanup levels or media-specific Performance Standards are described in detail throughout this *Record of Decision*.

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14 Statutory Determinations

The Selected Remedy described in this *Record of Decision* meets the statutory requirements of Section 121 of CERCLA, 42 U.S.C. § 9621 and NCP section 300.430(f)(5)(ii). These provisions require that CERCLA remedies be protective of human health and the environment, comply with ARARs or replacement standards for waived requirements, be cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

14.1 Protection of Human Health and the Environment

The Selected Remedy protects risks to human health identified in EPA's *Human Health Risk Assessment* (EPA 1998a) and *Human Health Risk Assessment Addendum* (EPA and ATSDR 2001) by establishing RBCs for arsenic contamination for areas within the Clark Fork River OU Reach A for reasonably anticipated land uses as Performance Standards. These levels will reduce the cancer risks for soils within Reach A to less than 1×10^{-4}, which is within EPA's acceptable level established by the NCP, and the hazard index for noncancer risks to below 1. Residential areas that exceed these levels were addressed, with limited exception, in the Deer Lodge Valley TCRA done prior to the issuance of the *Record of Decision*. The *Record of Decision* requires that the unaddressed areas be remediated to the established levels, and that follow-up operation and maintenance on areas addressed under the prior TCRA is done. The *Record of Decision* also requires the railroad trestle area to be addressed, which current data indicates exceeds recreational levels. It also requires an evaluation of historically irrigated areas outside of the TCRA area, other recreational areas, and agricultural areas remediated as described below to ensure that these areas are below the soil Performance Standards. Finally, it requires institutional controls and educational efforts to ensure that land use assumptions contained within the Selected Remedy are maintained and that shallow groundwater is not consumed for domestic purposes or spread until groundwater cleanup levels are obtained. The implementation of the environmental aspects of the remedy and natural attenuation will likely lead to the cleanup of contaminated shallow groundwater to the health-based groundwater Performance Standards established in this *Record of Decision*.

The Selected Remedy will address the terrestrial, erosional, floodplain stability, and aquatic risks described in this *Record of Decision* by eliminating slickens areas and treating impacted areas, and by addressing streambanks along Reach A and a limited portion of Reach B. Run-off during normal and high flows will be controlled and contribution of contaminant movement will be reduced, slickens pulse events will be eliminated, and terrestrial vegetation will be restored for productive land use and stream stability.

The Selected Remedy does not produce unacceptable short term risks. Such risks as worker safety, community safety from truck traffic and contaminant release, land use interference, and floodplain stability and run-off during construction can be readily controlled through careful planning. In addition, no adverse cross-media impacts are expected from the Selected Remedy.

14.2 Compliance with ARARs

The ARARs and replacement standards for this site that the Selected Remedy must comply with are identified in detail in Appendix A to the *Record of Decision*. Key ARAR requirements for this site are as follows:

- Water Quality Standards promulgated by the State of Montana
- Federal water quality criteria promulgated by EPA for copper only
- The Federal drinking water standard for arsenic as applied to both surface and groundwater
- State and Federal groundwater standards
- ESA requirements for animals and plants such as the bull trout—EPA will continue to consult with the FWS as described in the Biological Opinion for this project as remedial design goes forward
- Executive Order 11990—No net loss of wetlands: EPA will continue to consult with the FWS as described in the Biological Opinion for this project as remedial design goes forward
- State Solid Waste and Floodplain Management requirements addressing storage and management of wastes within the floodplain

Other criteria, advisories, or Guidance to be Considered during remedial design for this action are also identified in Appendix A.

EPA has invoked the ARAR waivers listed below for certain standards identified in the ARARs identification document used in the development of the final *Feasibility Study* and the *Proposed Plan* for the Clark Fork River OU.

A. The Copper Standard for Surface Water

The State of Montana established standards for surface water quality within the Clark Fork River OU under the State's Water Quality Act. EPA is waiving the copper standard ARARs and substituting Federal water quality criteria promulgated under the Federal Clean Water Act. The replacement standard is measured as a dissolved component. The replacement standard is reflected in the water quality performance standards noted in Section 8, page 2-48, and in Appendix A.

The basis for this waiver is the modeling information developed during the RI/FS for this site that demonstrated that none of the alternatives could achieve the State's copper standard. EPA is invoking the waivers described in Section 121(d)(4)(C) of CERCLA (the technical impracticability waiver) and Section 121(d)(4)(D) of CERCLA (the partial cleanup waiver) for the State's copper standard. As cleanup of upstream OUs such as those in Butte, Silver Bow Creek and the Warm Springs Ponds, and the Anaconda area creeks progress, some portions of the Clark Fork River OU may eventually meet the State standard.

B. Certain State Floodplain and Solid Waste Management Requirements/Federal Solid Waste Requirements

The State of Montana established requirements for the active management of wastes within a floodplain. Treatment of mining waste, as described in the portions of the Selected Remedy addressing in-situ treatment, is considered active management of waste. Some of the identified State standards basically prohibit the storage or disposal of wastes such as the mining waste found at the Clark Fork River OU within a 100-year floodplain. The Federal standards regulate how solid waste management is done. Some of the identified Federal standards prevent any contamination of groundwater beyond waste unit boundaries, and may be read to prevent in-situ treatment involving cadmium waste. The in-situ components of the Selected Remedy are not in compliance with these requirements.

EPA is waiving these standards for the in-situ components of the *Selected* Remedy. The specific requirements that are waived are noted in the ARARs Appendix A to this *Record of Decision*. The waiver does not apply to those areas, such as slickens or impacted areas, that meet the exceptions for in-situ treatment, designated in the Selected Remedy. EPA is invoking the waivers found at 121(d)(4)(C) (technical impracticability from an engineering perspective).

The waiver would apply to either exposed tailings areas or impacted soils and vegetation areas designated for in-situ treatment in the selected remedy description. EPA has determined that there exists sufficient uncertainty regarding the technical practicability from an engineering perspective for the very large-scale removal of all mining wastes and contaminated soils. The heterogeneity and distribution of the contamination would not provide for reliable removal of all the contamination and would not allow the remedy to be implemented within a reasonable time frame. The waiver does not apply to those contaminated areas designated for removal in the Selected Remedy.

14.3 Cost Effectiveness

In EPA's judgment, the Selected Remedy is cost-effective. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP § 300.430(f)(1)(ii)(D)). This was accomplished by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (were both protective of human health and the environment and ARAR compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of the Selected Remedy was determined to be proportional to its costs. The chart shown on in Exhibit 2-37 shows the overall comparisons done for the alternatives that met the threshold criteria (Alternatives 4 through 8). The estimated present worth cost of the Selected Remedy is approximately $122,000,000. Alternative 4 is less expensive, but does not provide the long-term permanence of reduction in mobility for one of the principal threat wastes (the slickens) at the site that is necessary. It therefore is not cost effective. Alternatives 7 and 8 are significantly more expensive than the Selected Remedy costs, have significant short term effectiveness problems, and therefore are not cost effective. The Selected Remedy, which is a combination of alternatives 4B4, 5D, and 6C and most closely resembles Alternative 5D, provides an appropriate balance among the three effectiveness criteria and its overall effectiveness is proportional to its costs. Relevant considerations for the cost-effectiveness determination include the following:

A. Exposed tailings and contaminated soils extend throughout the floodplain in Reach A and portions of Reach B (greater than 43 miles). Remedy must be implementable over large area.

B. Lack of vegetation and accelerated erosion jeopardize the geomorphic stability of the floodplain. Remedy must not increase this risk.

C. Arsenic and metals (especially copper) associated with the tailings and soils comprise the risk to aquatic and terrestrial systems. Remedy must mitigate this condition.

D. Most of the affected land is privately held. Long term disruption of land use is a concern.

It is important to note that more than one cleanup alternative can be cost-effective, and the Superfund laws and regulations do not mandate the selection of the most cost-effective cleanup alternative. The most cost-effective remedy is not necessarily the least-costly alternative that is both protective of human health and the environment and is ARAR or ARAR waiver compliant.

EXHIBIT 2-37
Matrix of Cost Effectiveness Data for the Clark Fork River OU *Record of Decision*

Alternative	Present Worth Cost ($000s)	Cost effect (+ - * ✓)	Long Term Effectiveness and Permanence	Reduction of TMV through Treatment	Short Term Effectiveness
4A1. In-Place Reclamation of Exposed Tailings and Other Impacted Soils (285 acres) with Streambank Stabilization (222,367 feet), Criteria 1	$18,897	-	Does not remove principal threat waste (exposed tailings). Least effective at reducing COC movement via bank erosion.	Reduces toxicity and mobility of most COCs. Does not reduce volume of contamination. Does not actively remediate surface or groundwater.	Relies exclusively on in-situ treatment with minor removal of specifically targeted areas including riparian areas and streambanks. This alternative creates less traffic/construction risks as a result. Moderate amount of time to implement (EPA estimates 10 years). Takes longer to achieve performance standards than more intrusive Alternatives 6, 7, and 8.

EXHIBIT 2-37
Matrix of Cost Effectiveness Data for the Clark Fork River OU *Record of Decision*

Alternative	Present Worth Cost ($000s)	Cost effect (+ - * ✓)	Long Term Effectiveness and Permanence	Reduction of TMV through Treatment	Short Term Effectiveness
4A2. In-Place Reclamation of Exposed Tailings and Other Impacted Soils (285 acres) with Streambank Stabilization (72,777 feet), Criteria 2	$24,348	-	Does not remove principal threat waste (exposed tailings). More effective at reducing COC movement via bank erosion than 4A1.	Reduces toxicity and mobility of most COCs. Does not reduce volume of contamination. Does not actively remediate surface or groundwater.	Relies exclusively on in-situ treatment with minor removal of specifically targeted areas including riparian areas and streambanks. This alternative creates less traffic/construction risks as a result. Moderate amount of time to implement (EPA estimates 10 years). Takes longer to achieve performance standards than more intrusive Alternatives 6, 7, and 8.
4A3. In-Place Reclamation of Exposed Tailings and Other Impacted Soils (285 acres) with Streambank Stabilization (160,450 feet), Criteria 3	$31,359	-	Does not remove principal threat waste (exposed tailings). More effective at reducing COC movement via bank erosion than 4A2.	Reduces toxicity and mobility of most COCs. Does not reduce volume of contamination. Does not actively remediate surface or groundwater.	Relies exclusively on in-situ treatment with minor removal of specifically targeted areas including riparian areas and streambanks. This alternative creates less traffic/construction risks as a result. Moderate amount of time to implement (EPA estimates 10 years). Takes longer to achieve performance standards than more intrusive Alternatives 6, 7, and 8.
4A4. In-Place Reclamation of Exposed Tailings and Other Impacted Soils (285 acres) with Streambank Stabilization and Riparian Corridor Buffer (264,000 feet), Criteria 4	$52,092	-	Does not remove principal threat waste (exposed tailings). More effective at reducing COC movement via bank erosion than 4A3. Riparian buffer zone provides greatest protection for bank stability.	Reduces toxicity and mobility of most COCs. Does not reduce volume of contamination. Does not actively remediate surface or groundwater.	Relies exclusively on in-situ treatment with minor removal of specifically targeted areas including riparian areas and streambanks. This alternative creates less traffic/construction risks as a result. Moderate amount of time to implement (EPA estimates 10 years). Takes longer to achieve performance standards than more intrusive Alternatives 6, 7, and 8.

EXHIBIT 2-37
Matrix of Cost Effectiveness Data for the Clark Fork River OU *Record of Decision*

Alternative	Present Worth Cost ($000s)	Cost effect (+ - * ✓)	Long Term Effectiveness and Permanence	Reduction of TMV through Treatment	Short Term Effectiveness
4B1. In-Place Reclamation of Exposed Tailings and Other Impacted Soils (867 acres) with Streambank Stabilization (22,367 feet), Criteria 1	$31,822	-	Does not remove principal threat waste (exposed tailings). Least effective at reducing COC movement via bank erosion.	Reduces toxicity and mobility of most COCs over a larger area/volume compared to 4A Alternatives. Does not reduce volume of contamination. Does not actively remediate surface or groundwater.	Relies exclusively on in-situ treatment with minor removal of specifically targeted areas including riparian areas and streambanks. This alternative creates less traffic/construction risks as a result. Moderate amount of time to implement (EPA estimates 10 years). Takes longer to achieve performance standards than more intrusive Alternatives 6, 7, and 8.
4B2. In-Place Reclamation of Exposed Tailings and Other Impacted Soils (867 acres) with Streambank Stabilization (72,777 feet), Criteria 2	$37,273	-	Does not remove principal threat waste (exposed tailings). More effective at reducing COC movement via bank erosion than 4B1.	Reduces toxicity and mobility of most COCs over a larger area/volume compared to 4A Alternatives. Does not reduce volume of contamination. Does not actively remediate surface or groundwater.	Relies exclusively on in-situ treatment with minor removal of specifically targeted areas including riparian areas and streambanks. This alternative creates less traffic/construction risks as a result. Moderate amount of time to implement (EPA estimates 10 years). Takes longer to achieve performance standards than more intrusive Alternatives 6, 7, and 8.
4B3. In-Place Reclamation of Exposed Tailings and Other Impacted Soils (867 acres) with Streambank Stabilization (160,450 feet), Criteria 3	$44,284	-	Does not remove principal threat waste (exposed tailings). More effective at reducing COC movement via bank erosion than 4B2.	Reduces toxicity and mobility of most COCs over a larger area/volume compared to 4A Alternatives. Does not reduce volume of contamination. Does not actively remediate surface or groundwater.	Relies exclusively on in-situ treatment with minor removal of specifically targeted areas including riparian areas and streambanks. This alternative creates less traffic/construction risks as a result. Moderate amount of time to implement (EPA estimates 10 years). Takes longer to achieve performance standards than more intrusive Alternatives 6, 7, and 8.

EXHIBIT 2-37
Matrix of Cost Effectiveness Data for the Clark Fork River OU *Record of Decision*

Alternative	Present Worth Cost ($000s)	Cost effect (+ - * ✓)	Long Term Effectiveness and Permanence	Reduction of TMV through Treatment	Short Term Effectiveness
4B4. In-Place Reclamation of Exposed Tailings and Other Impacted Soils (867 acres) with Streambank Stabilization and Riparian Corridor Buffer (264,000 feet), Criteria 4	$64,504	+	Does not remove principal threat waste (exposed tailings). More effective at reducing COC movement via bank erosion than 4A3. Riparian buffer zone provides greatest protection for bank stability.	Reduces toxicity and mobility of most COCs over a larger area/volume compared to 4A Alternatives. Does not reduce volume of contamination. Does not actively remediate surface or groundwater.	Relies exclusively on in-situ treatment with minor removal of specifically targeted areas including riparian areas and streambanks. This alternative creates less traffic/construction risks as a result. Moderate amount of time to implement (EPA estimates 10 years). Takes longer to achieve performance standards than more intrusive Alternatives 6, 7, and 8.
5A. Removal of Exposed Tailings and In-Place Reclamation of Other Impacted Soils (118 acres In-Place, 167 acres Removal, 18,370 feet Streambank Removal), Opportunity Ponds Disposal Option	$36,310	-	Removes principal threat waste of exposed tailings. Least effective at reducing COC movement via bank erosion. Permanent disposal in designated waste management area.	Eliminates toxicity, mobility, and volume of exposed tailings via removal. Reduces toxicity and mobility of most COCs through treatment over a larger area compared to 5A. Does not reduce volume through treatment. Does not actively remediate surface or groundwater.	Relies on removal of exposed tailings in concert w/in-situ treatment of impacted soils; amount of streambank remediation varies. This alternative creates less traffic/ construction risks as a result. Moderate amount of time to implement (EPA estimates 10 years). Takes longer to achieve performance standards than more intrusive Alternatives 6, 7, and 8.
5B. Removal of Exposed Tailings and in-Place Reclamation of Other Impacted Soils (700 acres In-Place, 167 acres Removal, 18,370 feet Streambank Removal), Opportunity Ponds Disposal Option	$50,717	-	Removes principal threat waste of exposed tailings. Least effective at reducing COC movement via bank erosion. Permanent disposal in designated waste management area.	Eliminates toxicity, mobility, and volume of exposed tailings via removal. Reduces toxicity and mobility of most COCs through treatment over a larger area compared to 5A. Does not reduce volume through treatment. Does not actively remediate surface or groundwater.	Relies on removal of exposed tailings in concert w/in-situ treatment of impacted soils; amount of streambank remediation varies. This alternative creates less traffic/ construction risks as a result. Moderate amount of time to implement (EPA estimates 10 years). Takes longer to achieve performance standards than more intrusive Alternatives 6, 7, and 8.

EXHIBIT 2-37
Matrix of Cost Effectiveness Data for the Clark Fork River OU *Record of Decision*

Alternative	Present Worth Cost ($000s)	Cost effect (+ - * ✓)	Long Term Effectiveness and Permanence	Reduction of TMV through Treatment	Short Term Effectiveness
5C. Removal of Exposed Tailings and In-place Reclamation of Other Impacted Soils (700 acres In-Place,167 acres Removal, 18,370 feet Streambank Removal), DCCA Disposal Option	$54,943	-	Removes principal threat waste of exposed tailings. Least effective at reducing COC movement via bank erosion. Disposal in newly created waste management areas.	Eliminates toxicity, mobility, and volume of exposed tailings via removal. Reduces toxicity and mobility of most COCs through treatment over a larger area compared to 5A. Does not reduce volume through treatment. Does not actively remediate surface or groundwater.	Relies on removal of exposed tailings in concert w/in-situ treatment of impacted soils; amount of streambank remediation varies. This alternative creates less traffic/ construction risks as a result. Moderate amount of time to implement (EPA estimates 10 years). Takes longer to achieve performance standards than more intrusive Alternatives 6, 7, and 8.
5D. Removal of Exposed Tailings and In-Place Reclamation of Other Impacted Soils (700 acres In-Place, 167 acres Removal), Opportunity Ponds Disposal Option with Streambank Stabilization and Riparian Corridor Buffer (264,000 feet)	$84,327	+	Removes principal threat waste of exposed tailings. More effective in reducing COC movement via bank erosion than 5C. Riparian buffer zone provides greatest protection for bank stability. Permanent disposal in designated waste management area.	Eliminates toxicity, mobility, and volume of exposed tailings via removal. Reduces toxicity and mobility of most COCs through treatment over a larger area compared to 5A. Does not reduce volume through treatment. Does not actively remediate surface or groundwater.	Relies on removal of exposed tailings in concert w/in-situ treatment of impacted soils; amount of streambank remediation varies. This alternative creates less traffic/ construction risks as a result. Moderate amount of time to implement (EPA estimates 10 years). Takes longer to achieve performance standards than more intrusive Alternatives 6, 7, and 8.
6A. Removal of Exposed Tailings and Other Impacted Soils (285 acres Removal, 43,845 feet Streambank), Opportunity Ponds Disposal Option	$48,225	-	Removes principal threat waste of exposed tailings, and limited volume of impacted soils. Least effective of the six alternatives in reducing COC movement via bank erosion. Disposal in designated waste management area.	Eliminates toxicity, mobility, and volume of exposed tailings and impacted soils via removal. No reductions in toxicity, mobility, or volume of impacted soils that are not removed. Does not actively remediate surface or groundwater.	Removal volume increases—potential traffic and equipment related accidents, risks to the stability of the floodplain, and the duration of the remedial activity before full implementation are short term risks, less than Alternatives 7 or 8.

EXHIBIT 2-37
Matrix of Cost Effectiveness Data for the Clark Fork River OU *Record of Decision*

Alternative	Present Worth Cost ($000s)	Cost effect (+ - * ✓)	Long Term Effectiveness and Permanence	Reduction of TMV through Treatment	Short Term Effectiveness
6B. Removal of Exposed Tailings and Other Impacted Soils (867 acres Removal, 95,000 feet Streambank), Opportunity Ponds Disposal Option	$80,712	-	Removes principal threat waste of exposed tailings, and greater limited volume of impacted soils compared to 6A. Provides additional reductions of COCs movement via bank erosion compared to 6A. Disposal in designated waste management area.	Eliminates toxicity, mobility, and volume of exposed tailings and impacted soils via removal. No reductions in toxicity, mobility, or volume of impacted soils that are not removed. Does not actively remediate surface or groundwater.	Removal volume increases—potential traffic and equipment related accidents, risks to the stability of the floodplain, and the duration of the remedial activity before full implementation are short term risks, less than Alternatives 7 or 8.
6C. Removal of Exposed Tailings and Other Impacted Soils, Opportunity Ponds Disposal option with Streambank Stabilization and Riparian Corridor Buffer (264,000 Streambank feet)	$110,478	+	Removes principal threat waste of exposed tailings, and greater limited volume of impacted soils compared to 6B. Riparian buffer zone provides greatest protection for bank stability. Disposal in designated waste management area.	Eliminates toxicity, mobility, and volume of exposed tailings and impacted soils via removal. No reductions in toxicity, mobility, or volume of impacted soils that are not removed. Does not actively remediate surface or groundwater.	Removal volume increases—potential traffic and equipment related accidents, risks to the stability of the floodplain, and the duration of the remedial activity before full implementation are short term risks, less than Alternatives 7 or 8.
7A. Total Removal Unless Overlain by Woody Vegetation (2,600 acres Removal, 131,583 feet Streambank Reconstruction), Opportunity Ponds Disposal Option	$161,614	-	Removes principal threat waste of exposed tailings, and removal of all estimated impacted soils unless they support woody vegetation. Reduction of COC movement via bank erosion. Disposal in designated waste management area.	Eliminates toxicity, mobility, and volume of exposed tailings and impacted soils via removal. No reductions in toxicity, mobility, or volume of impacted soils that are not removed. Does not actively remediate surface or groundwater.	Large soil removal effort—greater short-term risk based on potential for traffic and equipment related accidents, risks to the stability of the floodplain, and the duration of the remedial activity before full implementation occurs.
7B. Total Removal Unless Overlain by Woody Vegetation (2,600 acres Removal), Opportunity Ponds Disposal Option with Streambank Stabilization and Riparian Corridor Buffer (264,000 feet Streambank)	$179,381	-	Removes principal threat waste of exposed tailings, and removal of all estimated impacted soils. riparian buffer zone provides greatest protection for waste management area.	Eliminates toxicity, mobility, and volume of exposed tailings and impacted soils via removal. Eliminates source of COCs to surface and groundwater within the OU.	Large soil removal effort—greater short-term risk based on potential for traffic and equipment related accidents, risks to the stability of the floodplain, and the duration of the remedial activity before full implementation occurs.

EXHIBIT 2-37
Matrix of Cost Effectiveness Data for the Clark Fork River OU *Record of Decision*

Alternative	Present Worth Cost ($000s)	Cost effect (+ - * ✓)	Long Term Effectiveness and Permanence	Reduction of TMV through Treatment	Short Term Effectiveness
8A. Total Removal (3,500 acres Removed and 345,000 feet Streambank Reconstruction), Opportunity Ponds Disposal Option	$355,370	-	Removes principal threat waste of exposed tailings, and removal of all estimated impacted soils. Reduction of COC movement via bank erosion. Disposal in designated waste management area.	Eliminates toxicity, mobility, and volume of exposed tailings and impacted soils via removal. Eliminates source of COCs to surface and groundwater within the OU.	Largest soil removal activities—greatest short-term risk based on potential for traffic and equipment related accidents, risks to the stability of the floodplain, and the duration of the remedial activity before full implementation occurs.
8B. Total Removal, Opportunity Ponds Disposal Option, with Streambank Stabilization and Riparian Corridor Buffer (264,000 feet Streambank)	$368,438	-	Removes principal threat waste of exposed tailings, and removal of all estimated impacted soils. Riparian buffer zone provides greatest protection for bank stability. Disposal in designated waste management area.	Eliminates toxicity, mobility, and volume of exposed tailings and impacted soils via removal. Eliminates source of COCs to surface and groundwater within the OU.	Largest soil removal activities—greatest short-term risk based on potential for traffic and equipment related accidents, risks to the stability of the floodplain, and the duration of the remedial activity before full implementation occurs.
Selected Remedy: Combination of Alternatives 4B4, 5D, and 6, Removal of Exposed Tailings and In-Place Reclamation of Other Impacted Soils (700 acres In-Place, 167 acres Removal), Opportunity Ponds Disposal Option with Streambank Stabilization and Riparian Corridor Buffer (455,136 feet)	$122,000	✓	Removes principal threat waste of exposed tailings. Maximizes reduction of COC movement via bank erosion. Riparian buffer zone provides greatest protection for bank stability. Permanent disposal in designated waste management area.	Eliminates toxicity, mobility, and volume of exposed tailings via removal. Reduces toxicity and mobility of most COCs through treatment. Does not reduce volume through treatment. Does not actively remediate surface or groundwater.	Variations of Alternatives 4 and 5 tend to rank high by limiting the volume of materials for removal, reducing the impacts of treatment on the floodplain, and promoting a relatively short healing process for recovery.

Cost Effective Summary:

The Selected Remedy reflects a fair balance between the long-term and short-term effectiveness and permanence, reduction of mobility, toxicity, and volume, and implementability issues associated with these alternatives. Using the criteria found in NCP section 400.300(f)(ii)(D), EPA believes that Alternatives 7 and 8 would not be cost effective, and that the overall effectiveness of Alternative 5d best meets the cost effectiveness criteria. EPA believes the Selected Remedy is cost effective and will achieve benefits and effectiveness proportional to the expected costs.

Key

"+" more effective than previous Alternative

"-" less effective than previous or other Alternatives

* no change compared to previous Alternative

✓ most effective compared to other Alternatives

14.4 Utilization of Permanent Solution and Alternative Treatment Technologies (or Resource Recovery Technologies) to the Maximum Extent Practicable

This finding looks at whether the remedy provides the best balance of trade-offs among the alternatives with respect to the Balancing Criteria set in NCP § 300.430(f)(1)(ii)(B), with an emphasis on long term effectiveness and permanence and reduction in toxicity, mobility, and volume (see NCP § 300.430(f)(1)(ii)(E)). Modifying criteria were also examined in making this finding. In other words, the finding of practicability for use of permanent solution and alternative treatments to the maximum extent practicable is determined by looking at the remedy selection criteria.

EPA has determined that the Selected Remedy represents the maximum extent to which permanent solution and treatment technologies can be utilized in a practicable manner at the site. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the Selected Remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and bias against off-site treatment and disposal and considering State and community acceptance. EPA's balancing is explained in Section 10.2.10, page 2-71.

The Selected Remedy reduces mobility of the principal threat wastes through removal of the waste outside of the Clark Fork River floodplain and aggressive treatment of Class I streambanks. This provides for more certain long term effectiveness and permanence by reducing the uncertainty that would be associated with the application of in-situ treatment in these areas. The Selected Remedy also provides for long term effectiveness and permanence in the in-situ treated areas and Class II streambanks by employing careful in-situ treatment requirements to land where it is most likely to succeed (soils with existing vegetation and organic content and relatively lesser amounts of contamination. The Selected Remedy presents some short term effectiveness and implementability challenges, but these can be managed successfully. It avoids the more pronounced short term effectiveness, protectiveness, and implementability problems of Alternatives 6, 7, and 8. Cost effectiveness is discussed above in Section 14.3. The State has accepted the Selected Remedy as described in its concurrence letter, Appendix F. General community acceptance can be achieved through the modifications to the proposed remedy described in Section 15, page 2-159, and continued consultation and coordination with local officials and landowners.

14.4 Preference for Treatment as a Principal Element

The Selected Remedy addresses principal threat wastes (slickens material and Class I streambank areas) through removal of most of these wastes from the floodplain and appropriate disposal at Opportunity Ponds near Anaconda, Montana. There, these wastes may be partially treated or contained through use of capping and in-situ treatment technologies per ARWWOU's remedial requirements. If the waste is left in place, it will be treated using the in-situ technology described in the *Record of Decision*. Other waste in impacted areas or Class II streambanks will be treated using the in-situ treatment technology. This satisfies the CERCLA statutory obligations for preference of treatment as a Principal Element.

14.6 Five Year Reviews

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of remedial action at the Milltown/Clark Fork River Superfund Site, to ensure that the remedy is, or will be, protective of human health and the environment.

15 Documentation Of Significant Differences

The *Proposed Plan* for the Clark Fork River OU was released for public comment in August 2002. The plan identified a combination of Alternatives 4, 5, and 6 that most closely resembled Alternative 5D (streambank treatment, in-situ treatment of impacted areas with one exception, excavation of slickens with one exception, the human health component and ICs, construction BMPs, and land use BMPs for removal and in-situ treated areas aimed at creating a riparian buffer zone).

During the public comment period, significant public comment was received. All comments are addressed in the *Responsiveness Summary*, Part 3 of this *Record of Decision*. Comments and information submitted during the public comment period that led to significant changes to the *Proposed Plan* are explained below.

The State of Montana Natural Resource Damage Litigation Program (NRDP) submitted a study describing research that demonstrates the potential chronic risks presented to fish from arsenic. EPA has noted this research in its description of chronic risk in Section 7, page 2-39, and other locations in this *Record of Decision*. This information is important and further bolsters the need for an aggressive streambank component of the Selected Remedy for this site that will control streambank sloughing and contaminant release from banks. Additional detail about the streambank component is contained in Section 13.6.4, page 2-106, and Appendix B of this *Record of Decision* to ensure that this aspect of the Selected Remedy is implemented in a robust and permanent fashion.

The ATSDR noted that areas at which in-situ treatment was used should be checked through post-construction sampling for compliance with the health-based arsenic soil performance standards. It also noted that a prior recommendation to EPA will be addressed; namely, the trestle recreational area in Deer Lodge, since the area soil samples exceed soil arsenic Performance Standards for recreational use. Both concerns of ATSDR are addressed in the Selected Remedy.

Landowners and Powell County Commissioners expressed concerns about weed control, flexibility in application of removal and in-situ treatments on their land, traffic and safety issues, and the proposed width of the riparian buffer zone discussed in the *Proposed Plan*. These concerns have been addressed as follows:

- Weed control is emphasized in the Selected Remedy, as described in detail Section 13.10, page 2-123 of the *Record of Decision*.
- The Selected Remedy states clearly that the riparian buffer zone is flexible in width, and should be coordinated with a landowner's land use plans.
- The S*elected Remedy* describes EPA policy regarding PRP payment for access to land for remedy implementation, and emphasizes the need to coordinate BMP planning and payment considerations with existing programs when possible.

DOI and more than one hundred commenters emphasized the need to ensure that the remedy, as implemented at the Grant-Kohrs Ranch National Historic Site, be implemented in such a way as to ensure compliance with the ARARs which are unique to that site—the

NPS Organic Act and associated implementation statutes for the Grant-Kohrs Ranch National Historic Site. EPA has worked closely with NPS in developing the description of how the Selected Remedy must be implemented at the ranch to meet these concerns. The NPS also produced a *Human Health Risk Assessment* directed specifically at the Grant-Kohrs Ranch National Historic Site. That risk assessment is generally consistent with EPA's *Human Health Risk Assessment* and its addendum when values are adjusted for site-specific bioavailability information, and does not generally change EPA's conclusions about its risk assessments or its soils arsenic Performance Standards. The NPS assessment did identify an exposure scenario on the Grant-Kohrs Ranch National Historic Site for irrigation workers who spend time working directly in contaminated sediments in irrigation ditches. EPA has addressed this new information by including irrigation ditch evaluation in the ranch and in the human health component of the Selected Remedy.

Some public interest groups, particularly the National Wildlife Federation, discussed the need to ensure that the streambank stabilization component be a secure and permanent part of the final remedy designed to hold during high flow events. The Selected Remedy contains a detailed description of how the streambank stabilization component should be designed and emphasizes measures to ensure adequate protection against shear stresses on unstable streambanks, such as use of pre-vegetated coir inserts and submerged fiber mats.

16 Coordination With Natural Resource Damage Restoration Actions

The Clark Fork River OU has received considerable attention from Natural Resource Trustees, as described in section 107(f) of CERCLA. These trustees include the State of Montana, DOI, and the Confederated Salish and Kootenai Tribes. The trustees have individually undertaken efforts to develop restoration plans and/or secure restoration money from potentially responsible parties to restore the Clark Fork River OU to baseline conditions, or the condition that would exist absent the release of hazardous substances. The State developed a restoration plan which, if implemented, would provide for certain actions to restore the injured resources. The State's existing restoration plan is likely to be revised following issuance of this *Record of Decision*. The DOI is assessing injuries to Federally owned land along the Clark Fork River and, following issuance of this *Record of Decision*, will pursue appropriate restoration activities.

The Selected Remedy is not intended to and will not restore natural resources in and along the Clark Fork River to baseline conditions.

Each of these entities, separately or as a group, may select restoration actions applicable to the Clark Fork River OU. If this occurs, EPA will work with the trustees to coordinate implementation of the Selected Remedy with these actions to avoid duplication of effort and unnecessary costs and to maximize benefits to the area.

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